POWER

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The Place of the Engineer

MORE than five years ago I wrote, in another connection:

With the application to the eternal struggle against the forces of nature of accumulated knowledge and experience and scientific discovery; with the employment of the marvelous tools and machinery at our command; with facilities for handling, storing and distributing which have never been equaled; with uses found for many portions of the product formerly thrown away; with all the economies of aggregation which should result from doing things upon a big scale—a consumer ought to be able to exchange his day's work for more of the commodities of life than ever before. There is no physical reason for the high cost of living.

The grand-scale development in production and exchange of the past half-century has not been accompanied on the part of the public by any intelligent, controlling, directive effort toward overall efficiency.

The demand is known or ascertainable; the sources of supply are visible and controllable. There should be intelligent authoritative correlation, the one with the other. The means of storing periodical production in excess of current consumption should be applied to smoothing out disparities between contemporaneous supply and demand. The processes of preparation should be put upon a wholesome, hygienic and efficient basis, and the machinery of distribution should be so organized that each product would proceed systematically from producer to consumer by the cheapest route and without reselling except by retailers. The eventual price to the consumer should be cost plus a fair profit.

Such a system involves nothing more than the application of principles and methods already in daily use. Any good industrial engineer, given the authority, could put it into operation.

The importance of the engineer in bringing about plenty, contentment and general well-being is becoming increasingly apparent. A contribution to the effort toward a public realization of the part that the engineer is playing is a series of advertisements by the McGraw-Hill Co., Inc., the first of which appeared in the *New York Times* of October 6 as a message to the American Bankers' Association in convention at New York at that time. It read as follows:

Within the memory of the elders of today this nation has turned from a land of scattered agriculturists to a compact unit of industrial production. And this in the face of a multiplying population with multiplying food requirements; in the face of increased acreage with increased output per acre.

The change has come through the coming of a body of men known as engineers, who have delivered us from the consuming losses of chance by giving us the science of controlled and directed effort.

These engineers have reduced the proportionate population of the farms through providing the farmer with mechanical means of replacing human labor.

They gave industry impetus through providing it with equipment designed to construct the machinery and other devices required by the farmer, as well as the enlarged needs of a congesting urban population.

They have put machinery to do the drudgery of detail in office, store, factory, farm and home. They put methods into management, facts where guesswork had been, knowledge where ignorance had taken toll.

These engineers, of whom we hear so little and upon whom we are daily becoming more dependent, have carried out a successful and constructive revolution which has turned this country into the greatest of industrial nations.

Today they are making themselves felt in the reconstruction of our standards of intercourse, in the improvement of both social and industrial laws, in the betterment of ethical and moral principles.

They have earned this position of influence through having analyzed the purposes of life and evolving a science of progress founded upon fact.

You will do well to follow the activities of the engineer. Your future depends upon him — not merely your financial success, but the revaluation of our world and its progress out of chaos into sound prosperity.

Never in the history of the world have conditions been such as to permit, by the use of our increasing knowledge, power and facilities, the realization of the age-long dream of a safe, contented and happy livelihood for everybody who is willing to work for it. Much if not most of this possibility is due to the engineer, and to him should we look for its realization,

From Coal to Oil in Twenty-Six Days

ON SEPTEMBER 1, the New York Central decided to change over six boilers to fuel oil at its Yonkers plant. Twenty-six days later the first oil-fired boiler went on the line, although no tanks, heaters or pumps had yet been installed.

TO AVOID any possibility of a coal shortage tying up its electrified lines in and near New York City, the New York Central Railroad recently decided to change several of its boilers from coal to fuel oil. On Sept. 1 orders were given to change over four boilers at the Yonkers power station, located on the Hudson River near New York City, and put them on the line in the shortest possible time. The necessary equipment was ordered and the contracts let without delay.

By Sept. 3 a gang of men had started rebuilding the settings of four Babcock & Wilcox boilers equipped with Roney stokers. By Sept. 27 one of the settings had been completely rebuilt, including the installation of steam-jet burners. The 4-in. oil main, making a loop from the river end of the plant to the burners and back, was also in place. However, there was no permanent storage tank, and the inside equipment, consisting of small storage tanks, pumps and heater, was far from being completed. At first sight it might seem that this would have made it impossible to operate the burners, yet the boiler went on the line that day and has been in operation ever since. The story of how this was accomplished will be of interest to all engineers who may at some time be confronted with the sudden cutting off of their coal supply.

Barge Used as Floating Storage

An 8,000-bbl. oil barge fully loaded with 14—16 Baumé light Mexican topped crude was engaged for an indefinite period as floating storage, and tied up to the dock alongside the plant. Steam was carried from the plant through a 2-in. flexible connection to the barge, where it passed to the oil-heating coils and to a small simplex oil pump, both the coils and the pump being part of the permanent equipment of the barge. Another flexible connection ran from the pump discharge to the oil main, which projected through the wall of the boiler-room basement. After being heated to 160 deg. in the tanks of the barge, the oil was forced into the main by the simplex pump and made the circuit of the boiler-room basement. The pressure of 80 lb. at the pump allowed the burners to operate at 75 lb. A steady flow of oil was maintained considerably in excess of that required by the burners, the portion not used coming back to the dock through the return side of the main and passing to the barge tanks through a flexible connection. This excess flow was necessary to prevent the oil from cooling below a workable temperature.

Since the first oil-fired boiler started operation on Sept. 27, it has been running daily, while the other five were being changed over one at a time. On Oct. 24, when the accompanying photographs were taken, three boilers were running on oil and a fourth was practically ready to put on the line. At the same time the work on the settings of the fifth and sixth boilers was well along, and the installation of the inside oil-handling equipment was nearly completed.

This inside equipment is now in operation, and the oil is pumped directly from the barge to three tanks, each of 2,500 gal. capacity. These are located in the basement and will soon be surrounded with a concrete wall 12 in. thick. The space between the tanks and the wall will be filled with sand to reduce the fire hazard. After being heated from 160 deg. to 180 deg. by thermostatically controlled coils submerged in the tanks, the oil gravitates through a twin strainer to a pair of 7½ x 5 x 6-in. duplex pumps connected in parallel. These force it through a heater, where its temperature is raised to 190 deg. before it passes to the burners.

As no outside storage (aside from the barge) has been provided, it will be necessary, for the present, to keep the barge tied up to the dock whenever fuel oil is burned, replenishing the supply from time to time from other barges. At some future time, if operation with fuel oil is continued, two 30,000-bbl. tanks may be installed outside, probably on a foundation made by driving piles and building up land in the docking space shown at the right in the view of the plant at the top of the opposite page.

Demonstration Important to Coal Users

This station is used only for peak-load service, from 5 a.m. to 8 p.m. As conditions never require the operation of more than fourteen of the twenty boilers, it will not be necessary to change the oil-fired boilers back to coal if developments in the fuel situation should make it inadvisable to continue burning oil. In such a case the six oil-burning boilers may merely be shut down.

As already suggested, this installation was made, not only to conserve coal, but also to gain the practical information needed for use in a more serious emergency. The experiment has shown that, under the conditions prevailing in water-front locations in the New York district, it is possible to start with stoker-fired boilers and put them on the line with fuel oil in less than four weeks after the change has been decided upon. In view of the fact that the average power plant normally keeps coal on hand for three or four weeks' operation, this demonstration must be reassuring to engineers who may be confronted with the possibility of a coal shortage.

Station Generates 20,000 Kw.

The Yonkers station, where this installation was made, is one of two power plants furnishing energy to the electrified section of the New York Central Railroad. It supplies 11,000 volt, three-phase power generated by four 5,000-kw. vertical General-Electric turbines. The boiler room contains twenty 6,250-sq.ft. Babcock & Wilcox boilers of which fourteen are at present coal fired, five with Riley stokers, six with Coxe stokers and three with Roney stokers. Of the six boilers now operating on fuel oil, four are equipped with Enco burners, four to a boiler, and two with Hammel burners, three to a boiler. Each of these boilers is provided with an oil meter.

These changes were supervised by the Electrical Department of the New York Central Railroad under the direction of E. B. Katte, the chief engineer of electric traction.

Oil Barge Feeds Burners at Yonkers Power Station of New York Central Railroad

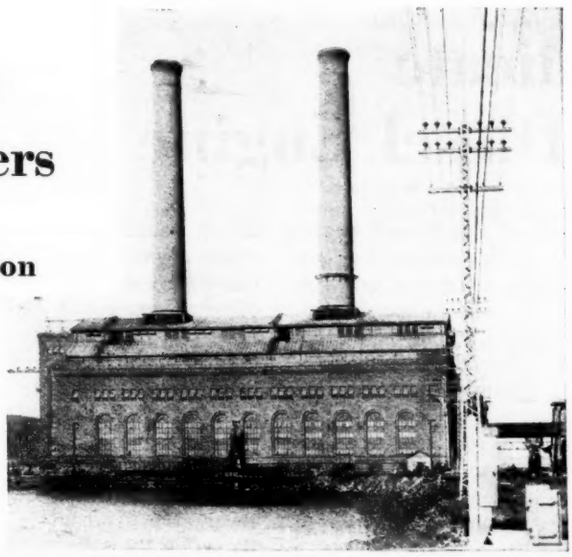
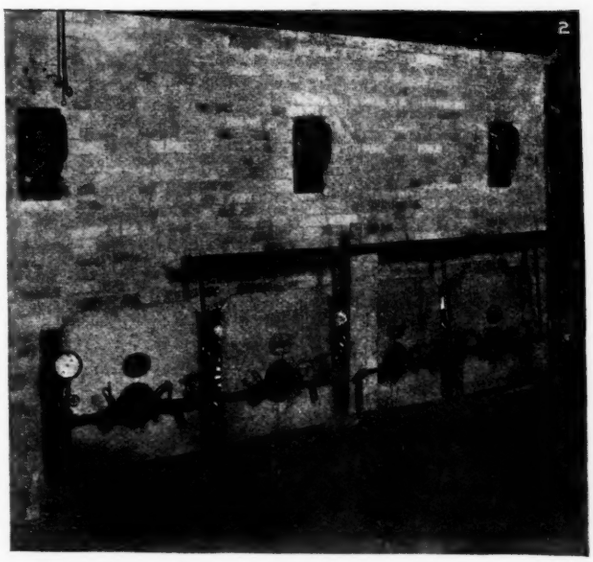
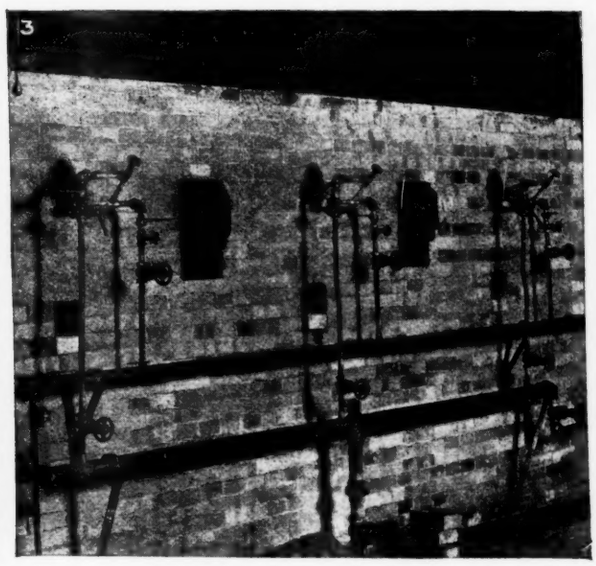


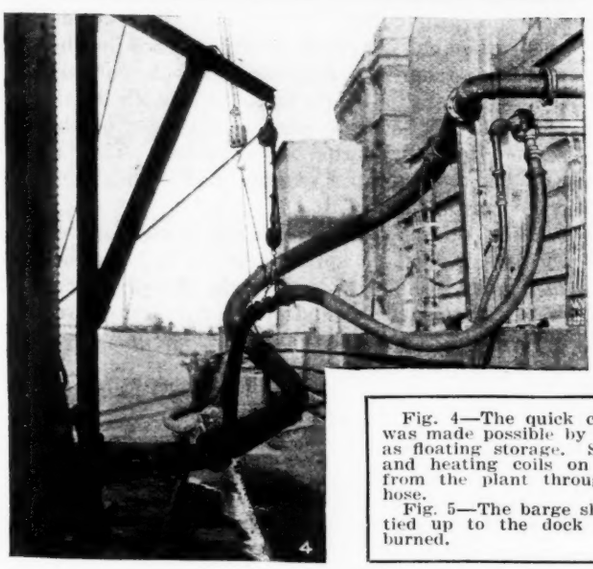
Fig. 1—On Sept. 1 all of the twenty boilers in the Yonkers power station of the New York Central Railroad were operating on coal, and no oil-burning equipment had been ordered. Twenty-six days later one of the boilers was burning fuel oil. In another two days the second boiler was fired, while work on two more was well advanced.

Fig. 2—One of the oil-burning boilers. Four of the six boilers now equipped for oil burning use the type of burner here shown.

Fig. 3—Another type of oil burner used on two of the boilers.







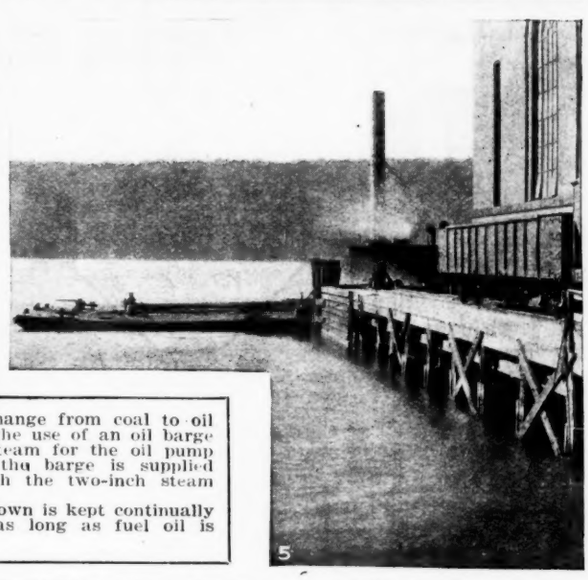


Fig. 4—The quick change from coal to oil was made possible by the use of an oil barge as floating storage. Steam for the oil pump and heating coils on the barge is supplied from the plant through the two-inch steam hose.

Fig. 5—The barge shown is kept continually tied up to the dock as long as fuel oil is burned.

Getting Ready To Indicate the Diesel Engine

IF a Diesel engine is to be kept in a first-class operating condition, an indicator must be used. This discussion covers the method of attaching the instrument to the engine and the steps to be taken in obtaining indicator diagrams.

THE rapidly increasing use of the Diesel engine and the semi-Diesel for both stationary and marine service has resulted in a general quickening of interest in these types of internal-combustion engines among operating engineers. The old belief that anyone can run an oil engine is rapidly giving way to the understanding that while economical performance is inherent in this type of engine and reliability is dependent upon correct design and manufacture, the full benefit of these two features can be realized in operation only by the intelligent application of ordinary engineering principles and a practical knowledge of what the engine is doing and why it does it. As a result the indicator has come to be regarded not simply as a laboratory and test-stand instrument, but also as a practical aid to the engine operator.

The principles of the indicator have been fully explained in previous articles on the steam-engine indicator, and the indicator for oil engines is practically the same. The difference is one of indicator-piston diameter. Owing to the high pressures in the heavy oil engine the steam-engine-indicator piston, which has ½-sq.in. area, would require an extremely heavy

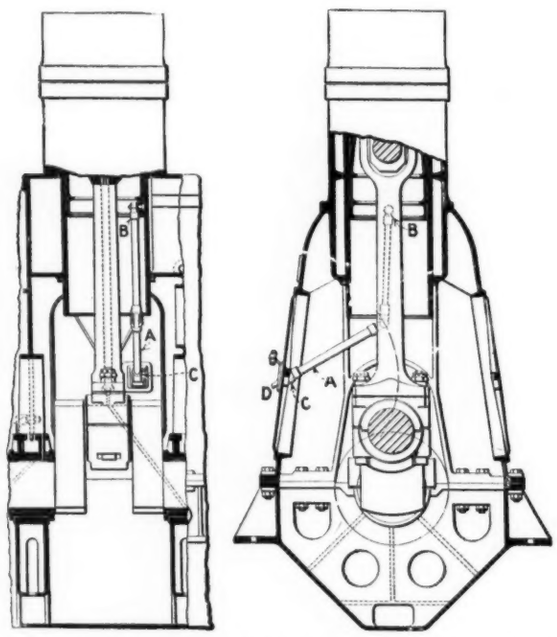


FIG. 1—INDICATOR RIGGING FOR TRUNK-PISTON ENGINES

indicator spring. It is usual to fit the oil-engine indicator with a piston of ¼-sq.in. area. In this way the 200-lb. steam-engine spring may be used and will then allow one inch of the travel of the pencil when a pressure of 400 lb. per sq.in. is exerted in the engine cylinder.

As with the steam engine the diagram obtained from an oil engine represents the pressure and volume conditions within the engine cylinder. The pressure scale has so large a ratio that the usual oil-engine indicator diagram may not be used to measure the indicated horsepower of the engine with the same degree of accuracy as in case of the steam engine having lower pressures. For computations where an error of 5 per cent is allowable, the indicated horsepower from the diagram is quite satisfactory. The majority of Diesel engines of 700 hp. and under have trunk pistons. For this reason the indicator riggings usually employed on steam engines may not be used on the Diesel. Even the large crosshead-type engine requires some special rigging. In Fig. 1 is shown a type of rigging often used on trunk pistons. The lever *B* is fastened to the inner wall of the piston by a screwed pin. The rocker *A* is fulcrumed on a pin *C* at the side of the crankcase door and is fastened to lever *B* by a bolt and knuckle joint. The indicator cord is looped over the hooked end *D* of the rocker *A*. There is a slight error in the diagram resulting from this rigging. If, however, the lever *A* is made of such a length that the knuckle joining *A* to *B* moves equal distances on the two sides of the cylinder center line, the error is negligible. This rigging is easy to make if the engine builder has not supplied some arrangement.

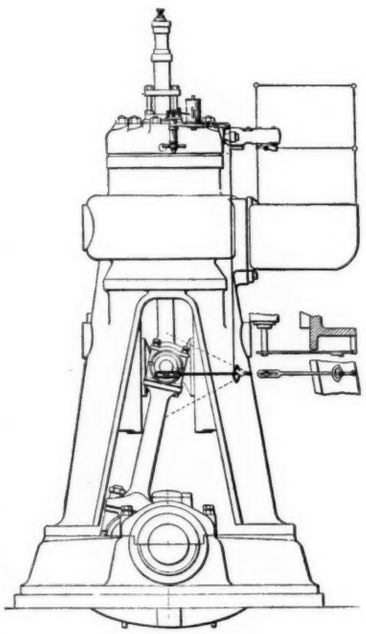


FIG. 2—RIGGING USED ON CROSS-HEAD-TYPE DIESELS

With this rigging, when the piston moves upward the indicator-drum spring tension is increased. If the cord has a tendency to stretch, the diagrams may be distorted toward the end of the compression stroke and during the combustion period. Errors at this point are of serious moment since the most important events in the engine cycle take place along this portion of the diagram.

Fig. 2 outlines an arrangement that is quite satisfactory for crosshead-type engines. By reason of the distance the crosshead is from the face of the frame, it is seldom possible to link the rocker arm direct to the crosshead. Usually, a stud of some length carrying the lever at the outer end must be screwed into the crosshead.

It will be noticed that the diagrams are accurate if the quadrant over which the cord passes is correctly made. The cord connection is such that, as the piston moves downward, the indicator cord is drawn out against the spring tension. If the cord stretches,

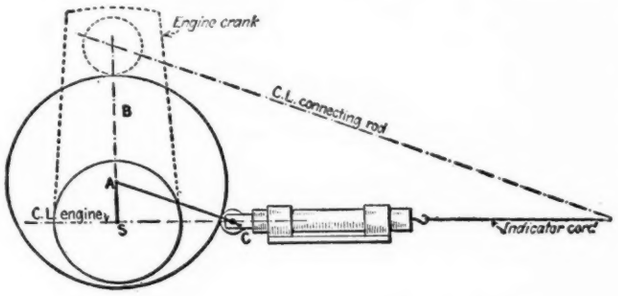


FIG. 3—AN EASILY CONSTRUCTED RIGGING

distortions of the diagram will occur toward the end of the expansion stroke, but this is not as serious as an equal amount of stretching at the other end of the diagram.

Many of the engines now in use were not fitted with indicator rigging and the engineer must supply the deficiency. Either of the two arrangements discussed may be used. Simpler and more easily applied devices are often made by the engineer. In Fig. 3 appears a device that is easily made and gives a correct diagram. This consists of an eccentric B clamped to the engine shaft with the eccentric throw SA in line with the engine crank. In constructing this motion, the relation of the radius of the eccentric B plus the radius of the roller C (the distance AC) to the engine connecting

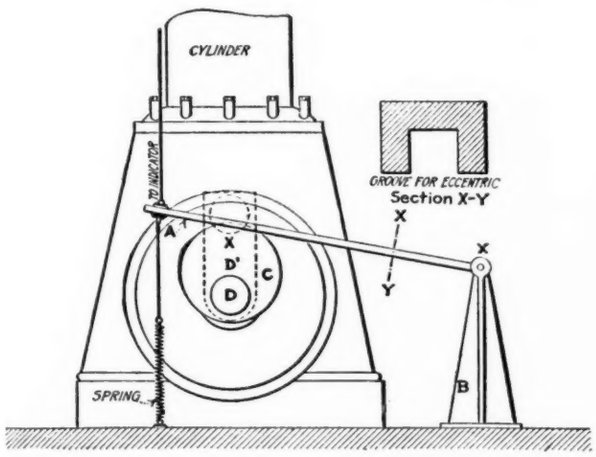


FIG. 4—AN ARRANGEMENT THAT MAY BE USED ON A NUMBER OF ENGINES

rod is equal to the ratio of the eccentric throw to the engine-crank throw, or

$$\frac{AC}{\text{Connecting rod}} = \frac{AS}{\text{Crank throw}}$$

Any engineer can make this, using a piece of steel rod for the slide and a piece of pipe with a babbitt liner for the guides. The eccentric can be made of cast iron, split and drilled for clamp bolts. In an emergency a hardwood eccentric with a brass strip on the edge may be used.

Instead of an eccentric the end of the engine shaft can be drilled for a small capscrew. A connecting rod of steel bar of a length such that the distance from the engine shaft S to the capscrew A bears the same ratio to the crank throw that the engine connecting rod bears to the rod AC will give a miniature connection rod AC and crank SA that reproduce to a smaller scale the action of the engine crank and rod.

An eccentric may be placed on the engine crankshaft and a lever A with a groove placed in the groove and fulcrumed to a stand B, Fig. 4. If the line connecting the center of the eccentric and shaft coincides with the crank line, then the travel of any point on the rod A will be proportional to the piston motion at all points in the crank circle. Hooking the indicator cord to a point on the lever such that the cord travel gives the desired diagram length, the apparatus is ready for use and the engine may be indicated.

The passage through the engine cylinder head to the indicator cock is usually very small, and if a stop cock is placed between cylinder and indicator cock, this

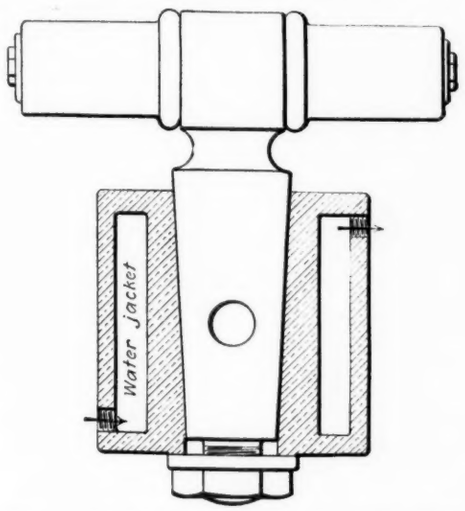


FIG. 5—WATER-COOLED INDICATOR COCK

passage through the stop cock is still smaller. It may happen that these passages will become partially choked with carbonized oil, especially in the stop cock. If this proceeds far enough, the passage will become constricted enough to reduce the gas flow sufficiently to give the effect of a lower pressure. As a result the operator may be misled as to the existing compression.

Anyone who has taken diagrams from an oil engine has had burned fingers as evidence of the temperature acquired by the whole indicator after a few minutes' use. Aside from the difficulty of handling a hot indicator consideration must be given to the bad effect on the indicator piston and cylinder. If the indicator remains on the engine for any considerable length of time and a large number of consecutive diagrams are taken, as in testing floor work, the piston will soon become leaky. A very useful device to prevent this and to eliminate from indicator work the burned-finger annoyance is a water-cooled stop cock, shown in Fig. 5. This can be left permanently attached to the engine cylinder, and the water-jacketed inlet and outlet may be connected at any convenient point in the circulating water system by means of small tubing. An indicator may remain attached to this cock for an indefinite period and will not get hot as long as the cooling water is circulating.

Source of Power for Large Industrial Plant*

By R. A. PACKARD
Superintendent of Power, Ludlow Manufacturing Association

ONE steam, two hydraulic plants and an emergency connection to public-service lines serve a collection of factories. Each distributing point has two or more sources of power, so that the mills were kept operating when a sleet storm cut the main transmission lines. Flexible supply prevents delays from power house or system troubles.

THE design of a system of electric power generation and distribution for a large industrial plant depends on such factors as available water power, condensing and feed water, unloading facilities for coal, the load center, subload centers, the character of load and the direction of any future plant expansion. These questions often arise: Shall the steam-power plant necessarily be located next to a hydro-electric plant, or shall it be kept apart? When there isn't any available water power, shall the steam generation be from one plant or two plants? These questions sum up to, Shall there be an underlying principle of single or multiple source of power generation? In the combined use of hydro-electric and steam-electric power an unusually attractive arrangement may be made for supplying uninterrupted electric service. Coupled with this combination there may be supplied a connection with the near-by public service corporation which may handle peak loads and thereby cut down an otherwise additional generating capacity or else serve as a stand-by. The management of a corporation may well afford to consider the advantages of a cheap and reliable private power system; illustrations of this having been done are frequent, and often manufacturers have expanded sufficiently to bring about a community center of their own, equivalent in most respects to the advantages of a city. A case in point is the generating, transmission and distribution of the Ludlow Manufacturing Association in Ludlow, Mass.; it is true that natural conditions have contributed largely to this satisfactory arrangement of power generation, but this does not hinder the realization of the advantages arising from multiple sources of power.

Sustained flow of the Chicopee River at Red Bridge, five miles above the factory, affords a fifty-foot fall for several thousand kilowatts during most of the year. Similarly, a modern hydro development at Ludlow in the mill yard, erected about three years ago, delivers power from the same water passed at Red Bridge, but under a forty-foot head. The steam-power station also located in the mill yard, acts as the stand-by equipment, the building affording room for a central connecting point of the 11,000-volt transmission lines from the two hydro-electric plants. This latter building also serves as a substation for 550-volt alternating-current distribution to the near-by mills. A substation in the mill-yard hydro plant also distributes 550-volt alternating-current power service. From the steam-power plant there is an underground 11,000-volt connection to the substation No. 3, where transformation of 550 volts alternating current, supplies power to the upper mills, which is the largest group supplied. In this substation a frequency-changer set reduces the Turners Falls Power Co.'s power from 60 to 40 cycles. Fig. 1 shows the sources of power and points of distribution, each point receiving power from either of two or more sources.

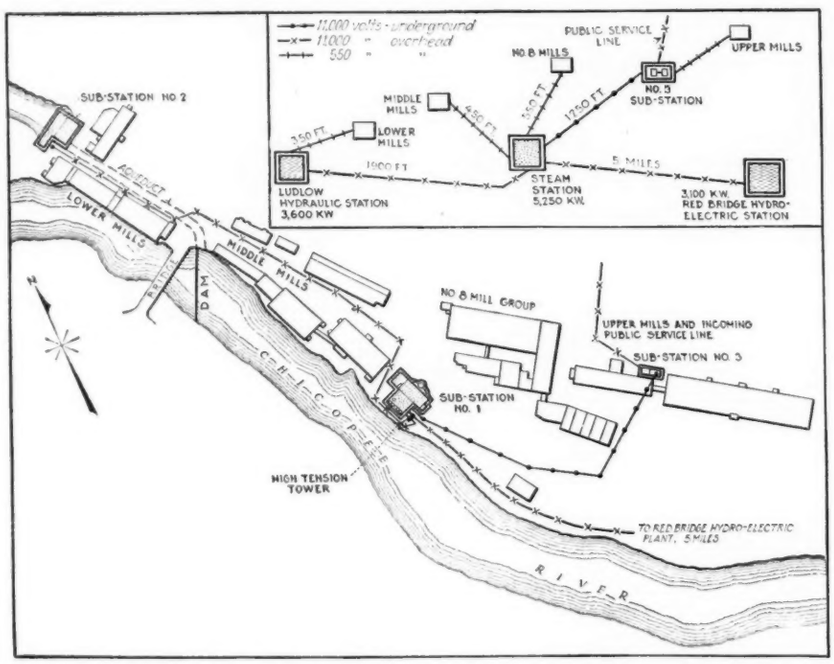


FIG. 1—TWO SOURCES OF POWER FOR EACH DISTRIBUTING POINT

Note: The 11,000-volt line from Ludlow hydraulic to steam plant is underground, instead of overhead, as legend indicates. Most of the 550-volt lines are underground. This information was received after the illustration was made.—EDITOR.

DOUBLE WATER STORAGE

The Red Bridge plant having a water-storage reservoir of 185 acres, and an installed capacity of 3,100 kw., while that in Ludlow 3,600 kw. with 62 acres five miles away, must be manipulated so as to keep the smaller lower reservoir from dropping too low under heavy power demand. The steam plant has 5,250 kw. stand-by capacity. The usual arrangement is to pull heavily

*From paper presented at Springfield, Mass., regional meeting, A.S.M.E., Sept. 25, 1922.

on Red Bridge when the mills start in the morning, to save water from wasting over the flashboards. At about 10 o'clock the water that passed Red Bridge at 7:30 begins to reinforce the reservoir at Ludlow. When the river flow runs low, the load at the Ludlow hydro plant must necessarily be cut down until sufficient supply of water has reached it from Red Bridge. On such days, during the last two hours of the afternoon the load on the former plant is increased to draw the water as low as possible so as to allow a single all-night service unit in operation at Red Bridge to fill up the restricted Ludlow reservoir.

Continuity of Service Enhanced by Multiple Supply Points

Of far more significance is the continuity of power service that this system upholds; an interruption of power in all the mills practically never happens. System trouble is more of a surge of frequency and voltage than anything else, due to a disturbance on some leg of the system and an accident at one plant may automatically dump its load to the remaining sources of power. Interruption of power service in a particular mill group never lasts more than two minutes, so flexible is the system for handling the situation. The correct design and proper control and overload protection have been installed along with correct designs for transmission and distribution. A dead short-circuit across one of the transmission lines, a breaking down of the insulation in the field coils of the 40-cycle end of the frequency changer set, or lightning surge in the transmission line have given a minimum of trouble. Take, for example, the most severe test that any transmission system has been called upon to stand during the last few years—that of the hail and ice

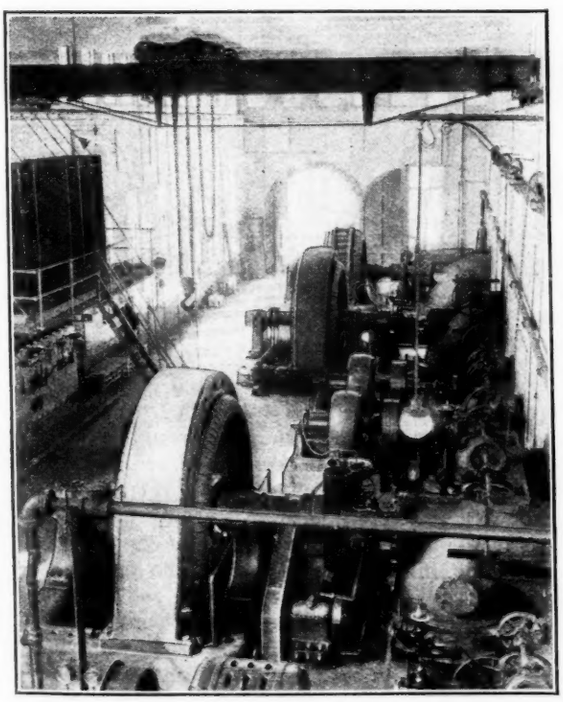


FIG. 2—GENERATORS OF THE LUDLOW HYDRO PLANT

storm of Dec. 5, 1921. Both Red Bridge transmission lines were down, due to high trees laden with ice which dropped across the wires. It was thought the "cut-back" along the line had been sufficient to clear these particular trees, but the severity of the storm wrought havoc in a most uncanny manner. The three remaining sources of power at Ludlow had to bear the burden of the load, allowing the mills to proceed with the usual program of production without much interference. The heating system in the mills was shut off and turned into the steam turbine, while the temperature outside was not sufficiently cold to cause discomfort, since the heat given off from the use of manufacturing steam and electric power was sufficient to maintain the rooms at a reasonable temperature. One of the transmission lines was cleared and into service by 10 a.m. that morning.

A proper installation shall consist of well-made joints and firmly secured conduits or cables; one weak link in the system may affect the efficiency of the whole.

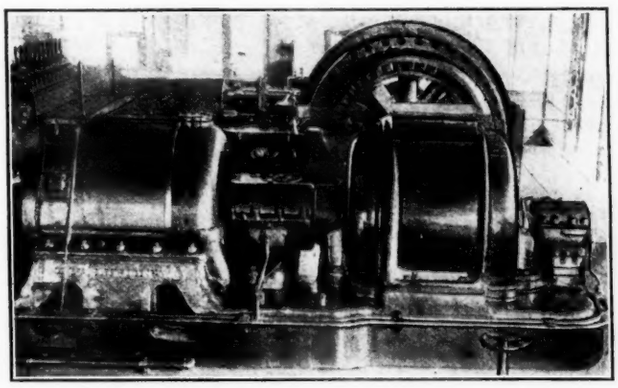


FIG. 3—IMPULSE TURBINE UNITS AT THE LUDLOW STEAM STATION

Many large industrial plants have their own centrally located steam-power station. From the point of view of economy of distribution of steam and power, the proposition is good; the unique and clever designs of stations and the almost perfect development of machinery and apparatus have gone a long way toward securing reliability of operation, but cannot quite equal a multiple source of power where failure of one automatically or nearly automatically calls on the other to support the load.

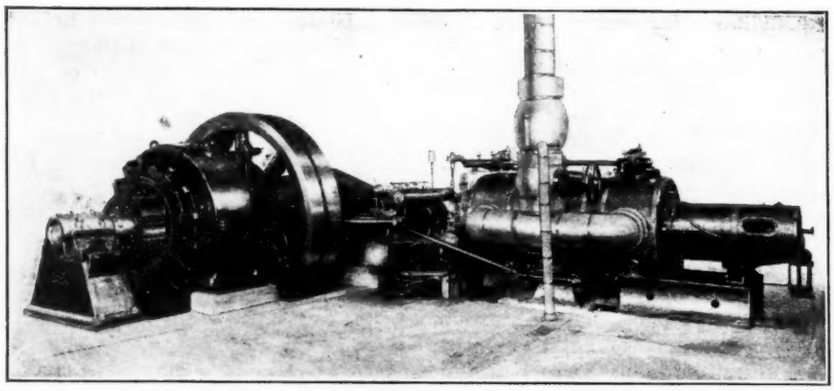
Some time ago the Ludlow mills were served with an isolated boiler plant near the Ludlow hydro-electric plant, a leftover of the old-time, slow-speed Corliss engine days, which had served its usefulness and was torn out. Concentration of steam generation can be handled most efficiently at the main steam plant. This illustrates conditions that have existed in other growing plants, the tendency in having too many sources of power both for steam and electricity, which, when reduced in number and remodeled, have served to greater reliability and economy.

Personnel an Important Factor

Once an ideal system of generation and transmission from a multiple source is in operation, its personnel of operation, inspection and maintenance is of great importance. A definite periodical examination of generating, transforming and distributing equipment is vitally necessary, while cleaning and inspection of compensators and motors will save heavy dividends. A large number of motors necessarily must be started and stopped by ordinary mill hands. No one should be allowed to handle such apparatus without first having been carefully instructed and having passed examination satisfactory to the electrical maintenance foreman.

Auxiliary Exhaust Valves on Unaflow Engines*

A Description of the Skinner Unaflow Engine Valve Gear and the Method of Setting the Valves



THE use of auxiliary exhaust valves on unaflow steam engines was first originated in this country to meet the prevailing operating conditions. Since the piston of the usual unaflow covers the exhaust ports when but 10 per cent of the return stroke is completed, excessive compression pressures will occur with atmospheric back pressure unless the clearance be made large. This clearance may be obtained by belling or concaving the piston heads. If this is done, the engine will not prove economical when operating condensing.

To avoid this large clearance when condensing, yet permitting it if for any reason it was necessary to operate non-condensing, several methods have been introduced such as clearance pockets automatically opening

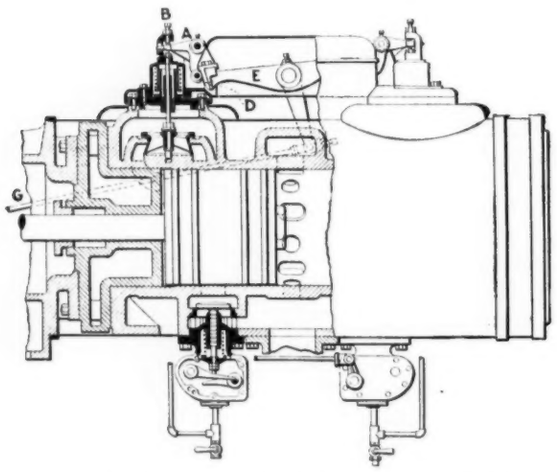


FIG. 1—UNAFLOW ENGINE WITH AUXILIARY EXHAUST VALVES

to the cylinder, and other devices. Among these is the plan of placing auxiliary exhaust valves on unaflow cylinders, which permits the engine to operate either condensing or non-condensing. In case the vacuum is lost, the engine with auxiliary valves at once meets the non-condensing conditions without distress.

In Fig. 1 is shown a cross-section of the Skinner unaflow engine with auxiliary exhaust valves. The steam valve, Fig. 2, is of the double-beat poppet design. To eliminate leakage resulting from unequal expansion of the valve and cylinder head, the top portion of the valve is separate from the valve body and is held down by spring tension. Expansion rings *A* prevent steam leakage between the two parts of the valve. Any inequality of expansion of the valve and seats is compensated for by a slight displacement of the upper part of the valve with respect to the valve body.

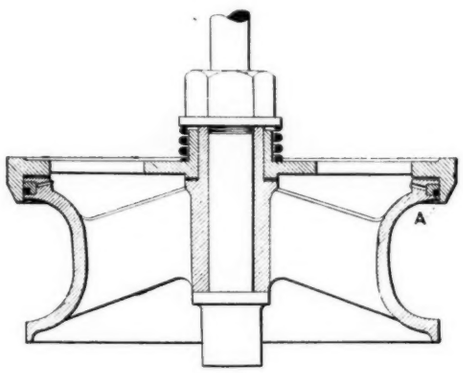


FIG. 2—EXPANDING DOUBLE-BEAT POPPET VALVE

The steam valves are opened by a bell crank *A*, Fig. 1, which carries a roller contacting with the cam *D* in the rocker *E*. This rocker is moved through a reach rod and rocker by the governor-controlled eccentric.

In setting the steam valves, the governor should be blocked with its weight arm in its outermost position, this being the overspeed position of the governor. With the governor in this position turn the engine in the direction it runs and adjust the reach rod and the cam rocker *E* until the cam just fails to open the valve. This will prevent the engine taking steam when the governor is in the over-speed position.

The steam valve is lifted by the end of the rocker *A* touching the setscrew *B*. There must be clearance between the rocker end and the setscrew when the engine is turned beyond the cutoff position. If not, the valve will be held open. This clearance should be about the thickness of an indicator card, say 0.003 in. After the setscrew is adjusted to give this clearance, the engine

*This is one of a series of articles giving practical directions for setting valves of unaflow engines.

should be turned to crank dead center. The governor should be blocked to its usual running position. The valve reach rod is then adjusted so that the rocker *A* just contacts with the setscrew when the crank is on dead center.

The engine should now be turned to head-end dead center and the reach rod adjusted to cause the rocker *A* to barely strike the setscrew *B* on the head-end valve. If not the setscrew and the cam must be adjusted. The valves are now correctly set. As a precaution the governor should be again blocked in its extreme outer position and the amount of clearance between the cam *D* and the rocker noted.

To set the auxiliary exhaust valves, it is necessary to see that the eccentric rod is of the proper length to cause the rocker arm to which it is attached to move the same distance from its vertical position when the eccentric is moved to its two extreme positions. With this completed, the engineer should determine the lift of the valves. Remove the covers from the sides of the exhaust cam boxes after draining out the oil; chalk the sides of the cam shifter *B* (Fig. 3) which is under the exhaust-valve stems *C* and scribe on it a vertical line, in line with the valve stem.

Now with calipers resting on the inside of the bottom of the exhaust cam box, scribe a line on the side of the

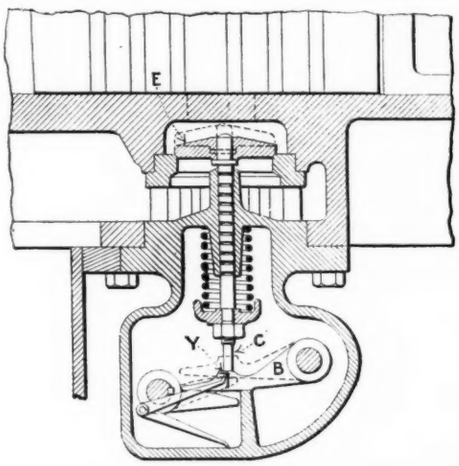


FIG. 3—SETTING AUXILIARY EXHAUST VALVES

cam shifter when the exhaust valve *E* is down on its seat, or closed. Then turn the engine and again scribe a line on the side of the shifter when the valve is in its topmost position. The difference between these lines will represent the lift of the valve, which should be as follows:

Engine Stroke	Distance, X
15 in.	$\frac{9}{16}$ in.
16 in.	$\frac{5}{8}$ in.
18 in.	$\frac{11}{16}$ in.
20 in.	$\frac{3}{4}$ in.
22 in.	$\frac{13}{16}$ in.
24 in.	$\frac{7}{8}$ in.
26 in.	$\frac{15}{16}$ in.
30 in.	1 in.
36 in.	1 in.

The valve lift may be regulated by movement of the exhaust reach rod and link rod, which have right- and left-hand threads. The crank-end valve should be adjusted before the head-end valve. When the exhaust valves are closed, the end of the stem should clear the shifter by the thickness of an indicator card. When the valve is wide open, the engineer should lift the valve with a lever a little farther to make sure that it is not striking anywhere at its extreme normal lift.

After the rods are adjusted to gain proper lift, the time of opening and closing of the valves should be regulated by the adjustment of the eccentric on the engine shaft. This should be shifted and locked in proper position so that the crank-end valve will close just before the piston reaches the crank end of its stroke. When so set, this crank-end valve will correspondingly open immediately before the piston reaches the head end of its stroke. The timing of the head-end exhaust valve should be similarly checked to close just before the crank is on the near dead center and to open just before the crank is on the far dead center. The eccentric is marked on the side toward the engine

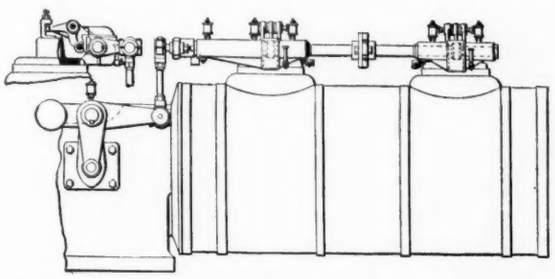


FIG. 4—VALVE GEARING FOR LARGE ENGINES

bed corresponding to a mark on the shaft, showing the setting at time of shop test.

The expansion of the cylinder of large engines is such that with the steam-valve gear already described, the valve setting may be impaired. To eliminate this derangement, the large Skinner unaflow engines are provided with a gear which compensates for expansion, as illustrated in Fig. 4. The valve itself is identical with those already shown, but the cam rockers are mounted upon a shaft running along the cylinder and which is driven by a linkage from the governor eccentric. The face of the valve cams are wide enough to

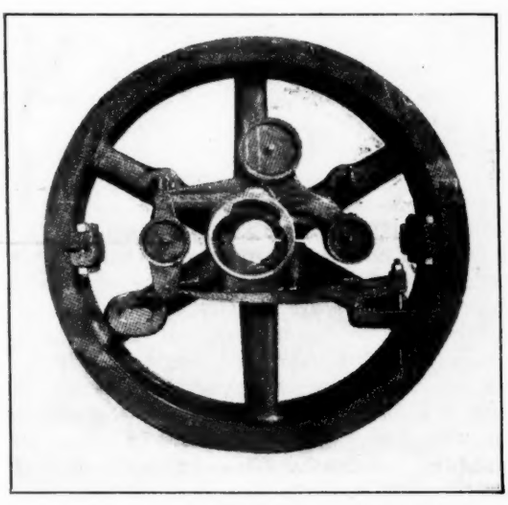


FIG. 5—SKINNER SHAFT GOVERNOR

permit the valve-lifting lever roller to slide along the face when the cylinder expands on warming up.

The method of setting the steam valve is the same as for the valves of the smaller engines. The governor used on both engines is shown in Fig. 5 and is of the combined centrifugal inertia type. Adjustments of the governor are made at the factory and seldom require any adjustment in the field.

Cause of Poor Cylinder Lubrication In Internal-Combustion Engines

By W. F. OSBORNE
Supervisor Manufacturers' Service, Texas Company

ONE of the most important factors that must be considered in the selection of a lubricating oil for internal-combustion cylinders is the temperature under which the oil must work. We know, in general, that very high temperatures will destroy the oil, cause it to break down with formation of carbon, and lose its lubricating properties. We know, too, that the viscosity is lowered as the temperature rises, that its adhesion is increased up to the point where vaporization takes place, and that evaporation increases with the higher temperatures. Before we can decide just what values these properties of the oil should possess, we ought to have a clear idea of the actual temperatures within the cylinder and how they vary.

The temperature is determined by many factors, such as the kind of fuel used, the method of supplying it to the cylinder, the condition in which it reaches the cylinder, the compression ratio, the ratio of expansion, the load factor of the engine, ignition conditions, the completeness of combustion, the rapidity of combustion, cylinder and piston design, degree of cooling, and a hundred and one other things. The temperature varies throughout the various portions of the cycle, no matter whether the engine be a four-stroke or the two-stroke explosive cycle or the Diesel or semi-Diesel. The single-acting four-stroke Otto cycle engine is the one in most common use and will serve our purpose very well.

Effect of Suction Temperature

Let us assume that our engine has been running for some time, the walls are coated with a good oil film and the running temperature has been reached. As the piston moves toward crank dead center on the suction stroke, it uncovers the oil film on the cylinder wall and exposes it to the direct action of the incoming fuel. So long as this fuel mixture is cool, there will be little effect on the oil film. Engines burning natural or illuminating gas receive the fuel mixtures at temperatures depending largely upon the temperature of the atmospheric air. When producer or blast-furnace gas is burned, the temperatures may be slightly higher, although such gases are usually cooled in order to increase the volumetric efficiency of the cylinder.

Engines receiving vaporized liquid fuel from a carburetor, may, under certain conditions, receive the fuel mixture at a fairly low temperature, sometimes below zero F. when being started outdoors in winter weather. The mixture is normally somewhat lower than the air temperature owing to the evaporation of the liquid fuel and the accompanying absorption of heat. Other engines, particularly those burning kerosene, have the fuel and air mixture heated before it enters the cylinder in order to improve the vaporization and combustion, such temperatures ranging from 200 to 300 deg. F.

Other things being equal, we expect that the high temperature of the fuel mixture coming in contact with the oil film would tend to raise its average temperature above that experienced when cold mixtures enter the cylinder. Instead of having any serious effect, the results are beneficial, as will be explained in a later article on the effect of fuel conditions.

As the piston moves up on the compression stroke, the temperature within the cylinder rapidly increases until it reaches a point just before ignition of from 400 to 1,000 deg. F. This temperature depends on the initial temperature of the gases within the cylinder at the start of compression, the ratio of compression and the cooling effect due to conduction of heat to the cooling water and through the metal of the piston and connecting rod.

The final compression temperatures of practically all engines are above the flash and fire points of the oils ordinarily considered suitable for internal-combustion cylinder lubrication. Certainly, there is some evaporation, and possibly some decomposition of the oil, but we must remember that the rate of evaporation is lowered as the pressure is increased, owing to compression, and the effect of the high temperature is partly offset. Again too, the piston is moving up all the time, and these maximum temperatures are not reached until most of the oil film has been covered by the piston and there is then little opportunity for trouble due to evaporation. The rising piston also wipes or spreads a fresh film of oil over the cylinder wall.

When Faulty Lubrication Exists

As soon as the mixture has been fired and the piston starts on its working stroke, the oil film is uncovered and exposed to the high temperature of the burning fuel. These temperatures range from 1,500 to 2,500 deg. F. and are high enough to destroy or burn up any lubricating oil made. Certainly, they are far beyond the flash or fire point of any known lubricating oil, the highest of which does not go over 725 deg. F. Any kind of oil is going to be affected to a certain extent at these temperatures, and all that we can do is to select such oils as have the best chance of remaining without causing any trouble when they decompose.

As the piston rises on the exhaust stroke, the film is still exposed to the high temperature of the burned gases, 500 to 1,700 deg., as shown, and it is still further destroyed. If any trouble from poor lubrication is experienced, it is likely to come on the exhaust stroke as the piston moves over a partly destroyed oil film, and a successful lubricant will be one that will alleviate the conditions as well as possible.

A motor or other part of electrical equipment is designed to do its work at a certain voltage and should not be expected to do its work properly unless this voltage is maintained within reasonable limits. Low voltage means a heavy current in the winding, which overheats the wiring, tending to destroy the insulation. Too high a voltage is also dangerous, as the spacing between parts has not been arranged for higher pressure and arcs are often caused which break down the insulation with resultant serious damage.—*Bureau of Mines.*

Ruling Factors in the Selection of an Ammonia Condenser

By L. C. MILLER

WHILE the first cost, fixed charges and operating costs are vital factors in determining the selection of an ammonia condenser, the limitations imposed by operating conditions, or the existing conditions of the installation, will often be the deciding element.

For example, there may be no space available either on a roof of a building or on the ground in the imme-

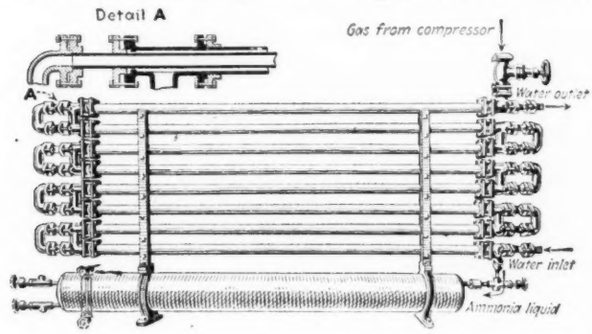


FIG. 1—DOUBLE-PIPE COUNTERFLOW CONDENSER

diate vicinity for the condenser. Under these conditions it must be placed in the engine room, in the basement or in some other part of the building. It may be required that the water from the condenser be delivered to some other point under pressure. In view of these circumstances a condenser of the closed-flow type should be used.

Double-Pipe Closed-Flow Condenser

Of the closed-flow condensers the well-known double-pipe type illustrated in Fig. 1 is the most extensively used. In this condenser the water is generally passed through the inner pipe while the ammonia is contained in the space between the inner and outer pipes. Where it must be delivered to another service after being used in the condenser, the water can be passed through this condenser and delivered to the desired point at any pressure up to the safe working pressure of the inside pipes. As a consequence the water can be used for two services with a single pumping. The condenser is also very flexible as to capacity, and a large capacity can be installed in a small space by forcing the water through it at a high velocity, something that cannot be done with an open-flow condenser.

The greatest objection to this condenser is the large number of joints, which are always liable to spring a serious leak at a time when the condenser is badly needed. This is particularly true on installations where there is only one or two stands. If the condenser is a large one, a blowout in one stand does not make much difference in the operating conditions and a stand can be cut out and repaired while the other sections carry the load. At the same time there are always ammonia leaks around a condenser of this type, particularly where high pressures and widely varying discharge temperatures are carried. The ammonia loss is always greater than in condensers of simpler construction.

The multi-tube condenser, illustrated in Fig. 2, has practically all the advantages of the double-pipe type and the number of joints has been reduced to a small fraction of those in the double-pipe type. In addition, for a given capacity it takes up a smaller space than any other type. It also requires considerably less power for water circulation than does the double-pipe condenser.

The condenser is constructed of large outside pipes having welded drop-forged steel heads on each end into which are expanded several extra-heavy charcoal iron tubes, the construction of each unit being practically the same as that of a shell-type cooler or a tubular boiler. The ammonia is contained in the inside of the large pipes and outside of the tubes, the water circulating through the tubes. This produces a high heat transfer and a very effective cooling surface with a minimum of friction loss through the stand. A large area return water bend connects each one of the large pipes, as will be noted in the illustration. Access to the tubes for inspection or cleaning is readily obtained by removal of the flanged connections of the water return bends. A study of the construction will show the remarkably few ammonia connections required.

Neither of these condensers, however, is very successful where water containing large quantities of mud or scale-forming matter is used. Very often it is found, in cases where high pressures and temperatures are car-

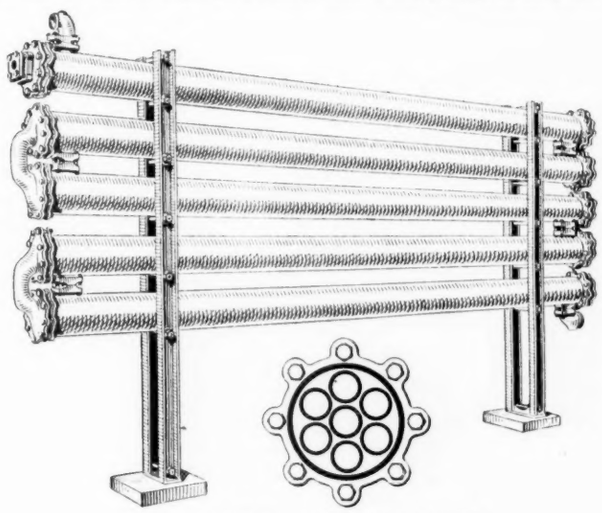


FIG. 2—MULTI-TUBE CONDENSER

ried, that the top pipes of a double-pipe condenser become badly scaled. This scale greatly increases the friction loss of the water through the condenser and reduces the capacity of the condenser. It is necessary to clean these tubes with a turbine cleaner to keep them in a high state of efficiency. The multi-tube construction is still more objectionable because the tubes, being smaller, are more readily plugged up. With either type there is a high maintenance expense where bad water is used. If the condenser is operated at low pressures

and temperatures, the trouble is not so pronounced, as the pipes or tubes will not scale up badly and can generally be cleaned out with a hand scraper.

Where there are no restrictions on space requirements, and particularly where it can be placed on top of a roof, the well-known atmospheric condenser, Fig. 3, will prove preferable if the water is bad. If the water is to be used for other services after passing over the condensers, a second pump will be needed, but if used in connection with a cooling tower, it will require less power for pumping than the double-pipe type. The number of joints is reduced to a minimum, and ammonia leaks are not so common. If mounted on a roof where there is a free air circulation, this condenser is economical in the use of cooling water, for considerable cooling effect is obtained by evaporation of the water as it flows down over the condenser. It has also the great advantage that it can be readily cleaned, is very accessible, and ammonia leaks are generally indicated at once by deposits at the defective joint.

Atmospheric Condenser Cannot Be Forced

The atmospheric condenser cannot be forced to greatly increased capacities like the double-pipe or multi-tube types, by circulating larger quantities of water over it. After a certain amount of water is passed over an atmospheric condenser, the water begins to splash off and is not utilized efficiently. This means a waste of water, and very little if any increase in capacity. It has another disadvantage. The hottest gas is brought in contact with the coldest water at the top of the condenser, and the warmest water comes in contact with the coolest gas. The gas as it enters the top of the condenser is generally at a temperature of from 200 to 260 deg. and about 20 per cent of the work of the condenser consists of reducing the gas temperature down to the condensing temperature, which is generally between 75 and 100 deg. This work can be done just as well with water at the temperature coming off the condenser as with the initial temperature of the water.

In order to get any action out of the bottom pipes of the condenser, the temperature difference between the water and the condensing gas must be at least four

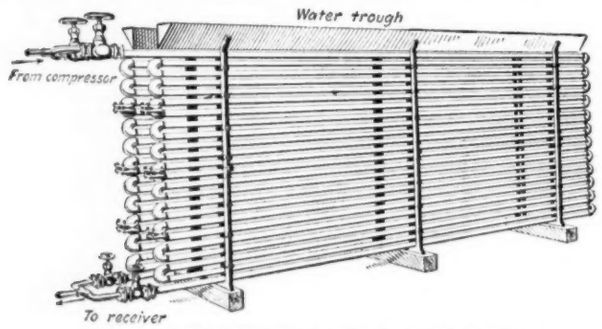


FIG. 3—ATMOSPHERIC-TYPE CONDENSER

or five degrees. This means that the condensing temperature for the whole condenser must be at least four or five degrees higher than the temperature of the water coming off the condenser. In other words, if you are operating with 70 deg. condensing water, a temperature rise of the water of 15 deg., and a temperature difference between the water and the condensing gas in the bottom pipes of 5 deg., the condensing temperature of the ammonia will be 90 deg., which corresponds with a condensing pressure of about 177 pounds.

The double-pipe condenser has a great advantage in this respect; here the coldest water enters at the bottom of the condenser and makes contact with the coolest ammonia gas. The warm water passing through the top pipes of the condenser is in contact with the hot superheated gas at this point, and a large proportion of the heat is delivered to the water at a high temperature difference. Consequently, while with the atmospheric condenser under the conditions given in the preceding

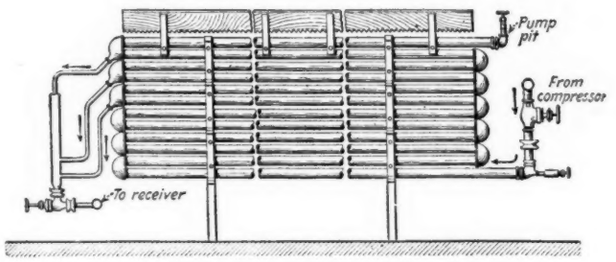


FIG. 4—BLEEDER CONDENSER

paragraph it is necessary to operate with a total temperature difference of 20 deg. between initial temperature of the water and the condensing temperature of the ammonia, with the double-pipe condenser it may be possible to operate with a total difference of 10 or 15 deg. A temperature difference of 15 deg. means a condensing temperature of 85 deg., which corresponds to a condensing pressure of about 152 lb. This allows a considerable reduction in the power consumption for practically the same operating conditions.

How the Bleeder Type Condenser Operates

The bleeder-type condenser, illustrated in Fig. 4, has all the advantages of the standard atmospheric condenser and at the same time it operates on the counter-current principle, which permits operation at lower condensing temperatures for a given set of conditions as with the double-pipe condenser.

In the bleeder condenser the gas enters at the bottom, in which the hottest gas comes into contact with the warmest water that is just ready to drop off the condenser. The coldest water at the top strikes the pipes containing the coldest gas, thus insuring a high rate of heat transfer for every pipe in the condenser. Air and foul gases are driven to the top where they accumulate and can be blown off at regular intervals. The liquid ammonia, as fast as formed, is drained off through the small bleeder pipes shown in the illustration. Maximum condensing effect for the whole condenser is obtained instead of carrying the whole quantity of liquid clear down through the bottom pipes, such as is the case with the double-pipe or atmospheric condenser. This condenser has also the advantages of small space requirements and light weight, which render them particularly adaptable for installations on a roof where special provisions have not been made to take care of the extra weight.

The flooded-type condenser, illustrated in Fig. 5, has in some respects the same advantages as the bleeder type, just described. For services where the exact operating conditions are known and where they remain practically constant, this condenser proves highly satisfactory. The space requirements for a given capacity are practically the same as those for a double-pipe or bleeder-type condenser. It is light in weight and has all the advantages of the standard atmospheric con-

denser as to tightness, ease of detecting leaks and ease of cleaning and inspection.

When a condenser of this type is operated under changing load conditions or fluctuating water temperatures, it is somewhat difficult to maintain satisfactory service. Even with the closest attention it is almost impossible to keep several of the stands of a large condenser from going out of action and becoming logged with liquid. The net result is that even if the load drops off considerably, or the water temperatures drop with changes of the season, the condenser pressure will remain high no matter how much condenser surface is installed. When a flooded condenser is operated at or near its normal capacity, however, it is both efficient in operation and economical in space requirements.

If the condenser is to be operated in connection with a cooling tower and the tower can be located above the condenser, a bleeder type would be the first selection

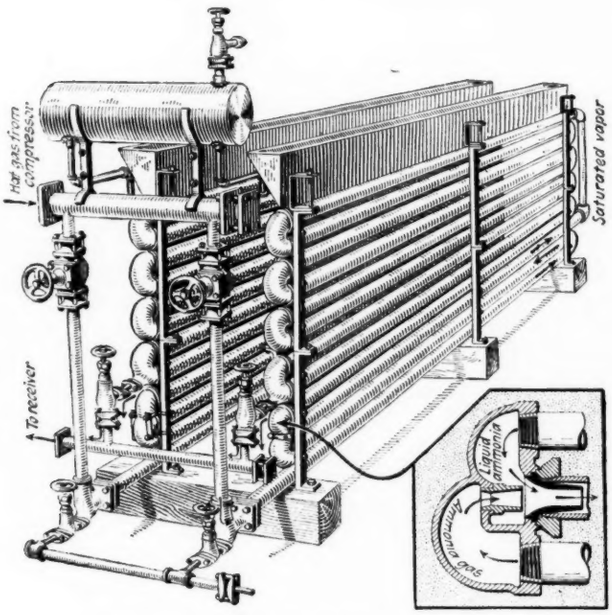


FIG. 5—FLOODED CONDENSER SHOWING INJECTOR ACTION

and the standard atmospheric or the various modifications of the same would be the second choice. If the tower is so located that the condenser cannot be placed below it, a double-pipe or multi-tube condenser will probably be the best selection, as this permits operation of the condenser with a single pumping, the water being pumped directly from the tower, through the condenser to the top of the tower again, forming a closed circuit.

Multi-Tube First Choice if Space Is Limited

If space requirements are limited, the multi-tube condenser will be the first choice, with the double-pipe or bleeder type a close second. If light weight is a consideration, the bleeder type is the first choice. If the water is muddy or carries a large amount of scale-forming matter and the temperatures are high, by all means select either a bleeder type, atmospheric flooded type or the standard atmospheric condenser. If the condenser has to be installed in the engine room or other part of the plant where the splash will be objectionable or where the water has to be delivered to other services after leaving the condenser, the double-pipe or multi-tube type is the logical selection.

Nothing has so far been said about cost. As a matter of fact a condenser of a given capacity costs practically the same regardless of the type. An atmospheric condenser requires considerably more pipe than a double-pipe condenser, but the latter has a larger number of fittings. The multi-tube type costs practically the same as the double-pipe. The bleeder type should from all considerations cost the least, owing to the minimum amount of material for a given capacity, but as a matter of fact it does not make much difference when prices are quoted for a unit of a given capacity.

An Air-Lift Paradox

By Frank Richards

An interesting question has come up as to the conditions and results of operating the air lift at considerable differences of altitude, whether there is loss or gain in the one extreme or the other and also whether advantage or disadvantage can be predicted for either.

The cost of producing any given volume of compressed air at any required pressure at any altitude has been already closely determined but, omitting this factor, we may say that with the air compressed and ready for the work, and for identical conditions of lift, submergence, etc., altitude without limit would seem to be favorable for the air lift rather than otherwise, but not perhaps in a way to be precisely computable.

The air pressure required for starting the flow of the air lift is determined by the height of the water from the lower end of the submerged discharge pipe to the surface of the standing water in the well, and the weight of this water and its consequent pressure, is not affected by the altitude of the location. If the surface of the water in the well is lowered when the air lift begins to flow, then the air pressure required to maintain the flow will be reduced proportionately.

When the lift is in full operation, the water that flows up the submerged discharge pipe and continuously overflows at its top is not at all driven upward by the direct pressure of the air. The ascending column of water has bubbles of air distributed all through it, each bubble of air displacing an equal bulk of water and therefore lightening the column of water to that extent, so that the entire movement is due to the greater weight of the unaërated water outside the discharge pipe.

The bubbles of air, when they begin their ascent at the bottom of the discharge pipe, are under the greatest pressure and are, consequently, individually small in volume. As they rise with the column of water, the water pressure decreases with the diminishing height, and the bubbles expand accordingly, thus each displacing an increasing volume of water and having a greater levitating effect as they rise higher and higher, so that we have here the paradox that the lower the air pressure the larger will be the air bubble and the greater will be its retroactive lifting effect. The bubbles at the upper end of the column and approaching the point of discharge, will therefore have a greater lifting effect upon the column as a whole than those at the lower end of it.

In a properly proportioned and adjusted air lift, the air, when it reaches the top of the discharge pipe with the water, should have so expanded as to have lost all its abnormal pressure and should escape with the water at the pressure of the external atmosphere. If we consider the career of an individual bubble of air rising up the discharge pipe, with the water, and expanding as it goes,

it will help us to understand the case. If, at the bottom of the discharge pipe the pressure is, say, four atmospheres, and at the top, just as the overflow or discharge occurs, it is one atmosphere, we can readily understand that the volume of the bubble, hence its water displacement and retroactive lifting power, is four times as great as at the bottom. The bubbles, as we know, do not maintain their individual identity all the way as they rise, but unite or break into each other when they come in contact, thus forming larger bubbles, but that does not in any way change the effect of the expansion.

In the foregoing, sea level conditions are assumed. As to altitude we may consider a rather extreme case—a height of 10,000 ft. and an atmospheric pressure of 10 lb. absolute. The volume of the bubble at discharge would then be nearly 50 per cent greater than if discharging at sea-level pressure, and it would have a correspondingly greater levitating effect. This, of course, would be quite a material advantage due entirely to the altitude, so that when the other conditions suggest an air lift the altitude should be an additional inducement rather than otherwise.

Nothing is said about slippage, which is the great source of loss in air-lift efficiency and which must be *greater* as the bubbles increase in size. It is to be remembered, however, that the slippage and other incidents of the rising column are entirely normal except for the short addition at the upper portion of the discharge pipe where, on account of the altitude, the pressure is less than at sea level, and the question of slippage can apply only to that upper extremity of the pipe.

Measuring the Contents of a Horizontal Tank

BY JOHN L. BOGERT

It is an easy matter to calculate the contents of a partly filled round vertical tank. With the total cubical capacity known, from the height and diameter, its contents when partly filled may be obtained by using the ratio of the depth of the liquid in the tank to the total tank depth.

When the tank is laid horizontally, the problem is somewhat complicated, since at different depths the cross-sectional areas are not proportional to the depths. If a table of contents and depths is to be prepared, it is necessary to calculate the volume increase or decrease when the depth changes. Since the volume increase is the product of the head area shown and the tank length, it is possible to calculate the increase in the volume with a given increase in depth, but this entails a large amount of work.

In the chart on the opposite page this has been done for a tank 10 ft. in diameter by 32 ft. long. In column 4 are given the contents of this tank with flat heads at each 2 in. decrease in depth of the tank contents, as given in Column 1, starting with the tank completely filled. Though this table is calculated for one diameter of tank, 10 ft., it is a simple matter to use it for determining the contents of cylindrical tanks of any diameter and length at sixty different depths. Bear in mind that with the number of depth divisions remaining the same (60) the thickness of the segment or division, width of segment and length of segment, will vary directly as the diameter of the tank. For example, take the case of a 60-in. diameter tank. Each segment will be half as thick, half as wide and have an arc half as long as the corresponding segment of the 120-in. diameter tank given in the table. Areas are proportional to the product of two dimensions, hence the number of gallons in columns 3 and 4 must be multiplied by 0.5×0.5 ($\frac{1}{2}$ square) or $\frac{1}{4}$ to be applicable to a 60-in. diameter tank; that is, by the ratio of the squares of the diameters. Also, the sixty depth divisions of a 60-in. diameter tank will be but 1 in. apart instead of 2 in. as in the case of the 10-ft. diameter tank given in the table.

If an engineer has a horizontal tank of any diameter, say 54 in., and 20 ft. long and with flat heads, it is no great matter to calculate the volumes at 60 equal dimensions of the tank diameter and set these volumes down in column 5. As example, the volume of the 54-in. x 20-ft. tank will, at any of the 60 divisions, be proportioned to the ratio of the squares of the diameters and to the ratio of lengths. Or, starting at the top of the tank, a decrease in depth of 1/60 of the diameter (1/60 of $54 = 0.9$ in.) will cause the 54-in. tank to have a capacity of $V = \frac{54 \times 54}{120 \times 120} \times \frac{20}{32} \times 18{,}732.48 = 2{,}370.8$ gal., while, when completely filled, its contents totals 2,379.46 gal.

Not all tanks have flat ends, and it is necessary to provide for the many with dished ends, though the only kind of dished end considered in the table is a spherical one whose radius is equal to the diameter of the tank.

In column 6 the volume of the head segments of the 120-in. x 32-ft. tank is shown. If the tank that is to be calculated has spherical heads, it is necessary to add to the volumes to be set down in column 7 the volumes of the spherical heads. Since the volumes of spheres are to each other as the cube of the diameter, it is necessary to multiply the values in column 6 by the ratio of the cubes of the diameters, or in case of a 54-in. tank by $\frac{(54)^3}{120}$ to obtain the volume in the two heads at any level. These volumes should be added to the volumes of the entire tank to give the total tank volume and set down in column 9. In order to simplify the work of calculating the values for tanks of different sizes, Table I has been prepared. In this table are given the factors by which the volume per foot length of a 10-ft. diameter tank in column 3 is to be multiplied to find the volumes of tanks of different diameters. The factor for the spherical heads under the desired tank diameter will, when multiplied by the value in column 6, give the volume of the two heads of the desired tank.

It is not necessary to have 60 divisions in case of small tanks. By using every other line in the chart, 30 divisions are secured. The tank measuring stick should be divided in 60 or 30 equal divisions. By using this table corrected for the actual tank diameter and length, the amount of oil or other liquid drawn out of or added to the tank may be readily obtained without computation at each time of measuring.

TABLE I—FACTORS TO BE USED IN COMPUTING TANK CONTENTS

Tank diameter, inches	30	36	42	48	54	60	66	72	84	90	96	108	114
Factor for plain end tank	.062	.09	.122	.16	.202	.25	.302	.36	.49	.562	.64	.81	.902
Factor for 2 spherical heads	.016	.027	.043	.064	.091	.125	.166	.216	.343	.406	.512	.729	.857

Capacity of Horizontal Tanks

1	2	3	4	5	6	7	8	9
Depth, Inches	Area of Head Segment, Sq.In.	Gal. per Foot of Length of 10 Ft. Dia. Tank	Gals. in 10 Ft. x 32 Ft. Tank	Division Number	Gal. in Spherical Heads	Gal. in Plain-End Tank	Gal. in Sperical Heads	Total Gal. in Tank
120	11,309.76	587.52	18,800.64	60	805.98			
118	11,268.76	585.39	18,732.48	..	805.78			
116	11,193.93	581.50	18,608.00	58	805.03			
114	11,098.35	576.54	18,449.28	..	803.50			
112	10,985.92	570.70	18,262.40	56	801.05			
110	10,859.63	564.14	18,052.48	..	797.59			
108	10,721.18	556.94	17,822.08	54	793.07			
106	10,571.99	549.19	17,574.08	..	787.45			
104	10,413.32	540.95	17,310.40	52	780.69			
102	10,245.93	532.26	17,032.32	..	772.81			
100	10,070.73	523.15	16,740.80	50	763.79			
98	9,888.42	513.68	16,437.76	..	753.64			
96	9,699.50	503.87	16,123.84	48	742.38			
94	9,504.58	493.74	15,799.68	..	730.04			
92	9,304.17	483.33	15,466.56	46	716.66			
90	9,098.70	472.66	15,125.12	..	702.27			
88	8,888.62	461.75	14,775.87	44	686.92			
86	8,674.29	450.61	14,419.58	..	670.66			
84	8,456.10	439.28	14,056.90	42	653.53			
82	8,234.51	427.77	13,688.54	..	635.59			
80	8,009.71	416.09	13,314.85	40	616.91			
78	7,782.04	404.26	12,936.38	..	597.53			
76	7,551.89	392.31	12,553.79	38	577.52			
74	7,319.52	380.23	12,167.52	..	556.95			
72	7,085.01	368.05	11,777.66	36	535.89			
70	6,849.19	355.80	11,385.66	..	514.40			
68	6,611.94	343.48	10,991.26	34	492.55			
66	6,373.61	331.10	10,595.10	..	470.41			
64	6,134.48	318.67	10,197.57	32	448.06			
62	5,894.81	306.22	9,799.17	..	425.56			
60	5,654.88	293.76	9,400.32	30	402.99			
58	5,414.95	281.30	9,001.47	..	380.42			
56	5,175.28	268.85	8,603.07	28	357.92			
54	4,936.15	256.42	8,205.54	..	335.57			
52	4,697.82	244.04	7,809.38	26	313.43			
50	4,460.57	231.72	7,414.98	..	291.58			
48	4,224.75	219.47	7,022.98	24	270.09			
46	3,990.24	207.29	6,633.12	..	249.03			
44	3,757.87	195.21	6,246.85	22	228.46			
42	3,527.72	183.26	5,864.26	..	208.45			
40	3,300.05	171.43	5,485.79	20	189.07			
38	3,075.25	159.75	5,112.10	..	170.39			
36	2,853.66	148.24	4,743.74	18	152.45			
34	2,635.47	136.91	4,381.06	..	135.32			
32	2,421.14	125.77	4,024.77	16	119.06			
30	2,211.06	114.86	3,675.52	..	103.71			
28	2,005.59	104.19	3,334.08	14	89.32			
26	1,805.18	93.78	3,000.96	..	75.94			
24	1,610.26	83.65	2,676.80	12	63.60			
22	1,421.34	73.84	2,362.88	..	52.34			
20	1,239.03	64.37	2,059.84	10	42.19			
18	1,063.83	55.26	1,768.32	..	33.17			
16	896.44	46.57	1,490.24	8	25.29			
14	737.77	38.33	1,226.56	..	18.53			
12	588.58	30.58	978.56	6	12.91			
10	450.13	23.38	748.16	..	8.39			
8	323.84	16.82	538.24	4	4.93			
6	211.41	10.98	351.36	..	2.48			
4	115.83	6.02	192.64	2	.95			
2	41.00	2.13	68.16	..	.20			
0	0.00	0.00	0.00	0	0.00			
6	3.00	5.00	2.00	..	10.00			

When To Ground Conduits and Motor Frames

By EDGAR P. SLACK
Assistant Engineer, Underwriters' Laboratories

THE first of a series of articles dealing with When, How, and Why to ground conduit and motor frames, based on the National Electrical Code Requirements.

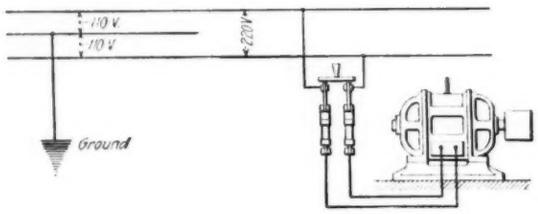
BEFORE discussing the particular subject of grounding conduits and motor frames, a broad classification of the various grounds used in electrical installations may be made as follows:

The circuit ground, which is connected directly to one of the circuit wires. For direct-current systems the circuit ground is made at the power plant, and for alternating-current systems the premises served are individually grounded either at the transformer secondary or at the service entrance.

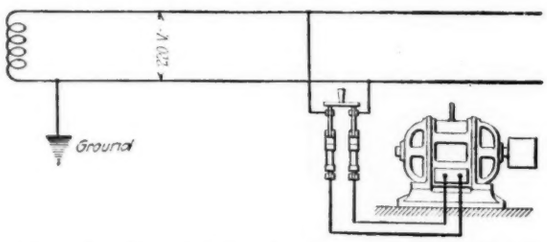
Raceway grounds, connected to metallic conduit, armored cable, metal molding or other metal raceways. These grounds are required for all metal raceways except that the grounding of service conduit and short lengths of raceway may be omitted under special conditions.

Equipment grounds, connected to the frames of electrical equipment, such as motors, generators, transformers, autostarters, inclosed switches, and the like. The equipment ground is often combined with the raceway ground, the requirements being similar in most respects.

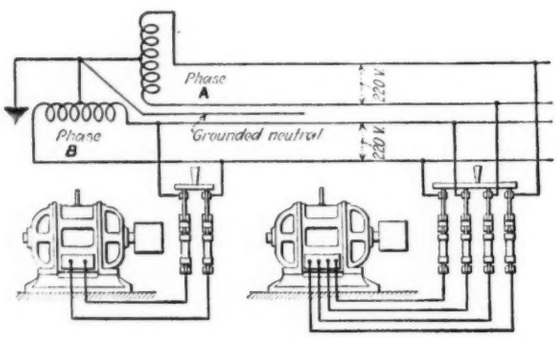
Lightning-arrester grounds, connected to lightning arresters and intended to carry to ground electric charges which may accumulate on outside overhead lines, due to thunder storms or other causes.



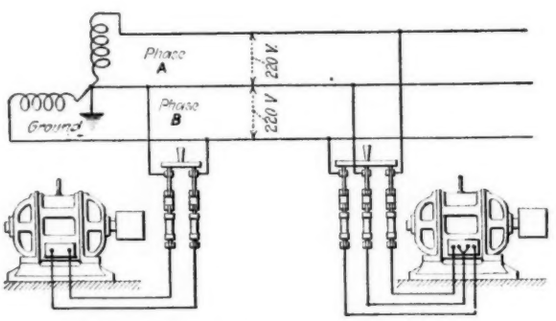
Three-wire 110/220-volt alternating-current or direct-current system with grounded neutral.
220-volt motor connected to outside lines.
Maximum voltage to ground is 110 volts.



Two-wire 220-volt alternating-current system with one line grounded.
220-volt single-phase motor connected to lines.
Maximum voltage to ground is 220 volts.



Five-wire 110/220-volt two-phase system with grounded common neutral for both phases.
220-volt two-phase motor connected to both phases or 220-volt single-phase motor connected to either phase.
Maximum voltage to ground is 110 volts.



Three-wire 220-volt two-phase system with common line grounded as shown.
220-volt two-phase motor connected to both phases or 220-volt single-phase motor connected to either phase.
Maximum voltage to ground is 220 volts.

If accessible only to qualified attendants, there are no requirements as to grounding the motor frame in the above cases, the maximum voltage to ground being below 150 volts. If accessible to others, the frames must be grounded.

In the above cases the maximum voltage to ground is more than 150 volts. Motor frames must therefore be grounded, unless the machines are accessible only to qualified attendants, in which case frames may be either grounded or permanently and effectively insulated.

Referring to grounds for raceways and for motor frames, as being of interest to the largest number of installation men, the following notes deal with the question as to when such grounds should be provided. The requirements given are those of the National Electrical Code and are generally followed by inspection departments throughout the country.

For raceway grounds the N. E. Code requires that in inside work (including all work for light, power and heat protected by service cutout and switch), where the wiring is done in metal raceways, whether conduit, armored cable or metal molding, the raceway shall be grounded, except for service raceways and short runs of interior raceways, the exception being as follows: "Where runs of armored cable, conduit or metal raceway not over 25 ft. long or service runs of any length are used for the protection of wires and are installed in other respects in accordance with Rules 27 for armored cable, 28 for conduit or 29 for raceways, these runs need not be grounded if the runs of armored cable, conduit or raceway are insulated from ground and from metal conduit, armored cables, metal raceways and metal work on the premises and are either isolated or guarded when within reach from grounded surfaces."

When Grounding of Motor Frames Is Required

The grounding of motor frames is required for motors operating at more than 150 volts potential and accessible to other than qualified attendants. The Code further requires that when frames are not grounded and the voltage of the circuit exceeds 150 volts to ground, the frames shall be permanently and effectively insulated from ground. It should be specially noted in these rules that the value 150 volts refers in some cases to the line voltage of the supply circuit and in other cases to the voltage between the circuit and ground. The following table shows how these rules apply in practice to motors of various ratings, accessible to qualified attendants only or to others, and operated on various systems:

Voltage Rating of Motor 0-150 Volts	Voltage Rating of Motor More than 150 Volts		
	Accessible Only to Qualified Attendant		Accessible to Other Than Qualified Attendant
No Requirements	Voltage to Ground 0-150 Volts	Voltage to Ground More Than 150 Volts	Frame must be grounded
	No requirements	Frame must either be grounded or permanently and effectively insulated	

For 110- and 115-volt motors: It will be seen that for 110-volt and 115-volt motors there are no requirements, and under the Code no attention need be paid to grounding the frames of such motors, whatever their horsepower rating may be.

For 220- and 230-volt motors: In power stations and in some mills and factories where the equipment is in separate rooms or enclosures, the motor and its control apparatus are accessible only to qualified attendants; and in this case the action to take depends on the voltage to ground. This voltage can be measured, when there is a permanent ground on the system, by a voltmeter with one terminal connected to ground, the other terminal connected to each of the supply lines in turn. If the voltage reading to ground is not more than 150 volts for any supply line, no attention need be paid to grounding the motor frame. If, however, the voltage to ground is found to be over 150 volts, then the frame must either be grounded or permanently and effectively insulated.

For most systems the voltage to ground is known, and so the action to take can be determined without the need of direct measurement. Some of the more usual cases are shown in the accompanying chart. All these 220- and 230-volt motors, if accessible to other than qualified attendants, must have their frames grounded regardless of how connected.

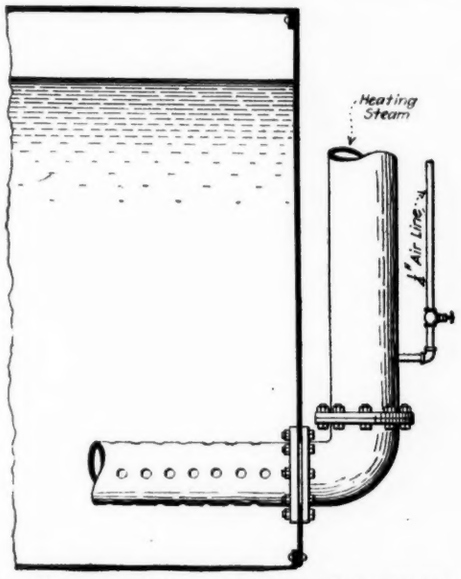
For 440-volt and higher-rated motors: If accessible to other than qualified attendants, these motors must have their frames grounded. When accessible only to qualified attendants and used on grounded systems, the maximum voltage to ground will exceed 150 volts, and the frames may either be grounded or permanently and effectively insulated.

In cases where there are no requirements as to whether to ground the motor frame or not, it is generally considered better practice to ground the frame if the supply circuit is fed from a transformer of 2,200 volts or over, and to insulate the frame if the power is supplied by a low-voltage isolated plant where there are no high-voltage lines that the motor circuit is likely to become crossed with.

Eliminating Vibration When Steam Is Injected Directly into Water

By Claude C. Brown

For the heating of water or other liquids in tanks it is often convenient to inject live or exhaust steam directly into the body of the liquid by means of a perforated pipe or coil. There are many objections to this method of heating, the most troublesome one being the excessive vibration and rumbling set up throughout the tank by the condensation of the steam.



INJECTING AIR IN WITH THE STEAM ELIMINATES VIBRATION AND NOISE

We have overcome this trouble in our plant by injecting a small amount of compressed air into the steam line just before the steam enters the tank, as shown in the illustration.

Corrosion—Apparatus To Prevent It*—II

AS THE fifth installment in the series on feed-water treatment and the third on corrosion, the present article describes two types of deaërators, one of which is new to American engineers, and the other an entirely new development. The first article on corrosion showed that oxygen is the ordinary cause of this nuisance, and described the Kestner deactivator. The second described the Elliott deaërator and two types of apparatus made by the Anti-Corrosion Co Of the two latter, one

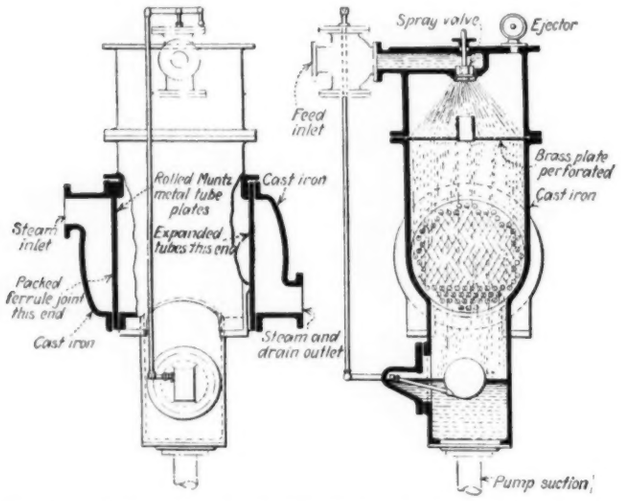


FIG. 1—"CONTRAFLO" DEAERATOR OF AMERICAN DESIGN

was a deactivator—removing oxygen only—while the other was a combination apparatus in which the oxygen-removal work to be done by the deactivator element was reduced by first removing most of the dissolved gases in a deaërating element.

The distinction between a deactivator and a de aërator, as already suggested, is that the former removes oxygen alone, while the latter removes all dissolved gases. The methods used are fundamentally different in that deactivation is a chemical process in which the dissolved oxygen uses itself up in the act of corroding a mass of finely divided iron or steel, while deaëration is entirely a physical process depending chiefly upon a reduction of the partial pressure of the gas over the water. The various kinds of deaërating apparatus differ from each other principally in the exact method of reducing the partial pressure and in the provision made for dissentangling the bubbles of entrained air.

Water Sprayed Over Steam-Heated Tubes

We will first give a brief description of the "Contraflo" deaërator, which is now being manufactured in this country for the first time, and concerning which only a limited amount of information is at present available. Referring to Fig. 1, the operation of this apparatus is as follows: The feed water, after passing through a float-controlled valve, which maintains a constant water level in the storage space, is sprayed into the vacuum chamber. The spray is caught by a perforated brass plate, and then falls over tubes heated by exhaust steam.

A vacuum running up to twenty inches or more, depending upon the desired final temperature of the feed water, is maintained in the deaërator shell, so that the water falling over the tubes is violently boiled at a temperature corresponding to the vacuum. This boiling releases the dissolved gases, which pass up with the vapor through the falling drops of water and then through the opening in the center of the brass plate and out through the spray to the ejector connection at the top of the deaërator. A large part of the rising vapor is absorbed in heating up the falling water. The remainder of the vapor, together with the gases is drawn off by the ejector. The counterflow of water and vapor not only cools the discharge vapor and gases to the lowest practicable point, but also brings the water practically to the boiling point before it strikes the tubes.

After leaving the ejector, the air and vapor, together with the ejector steam, go to a small surface condenser where the vapor is condensed while the air passes off through a vent. The heat in the ejector discharge is

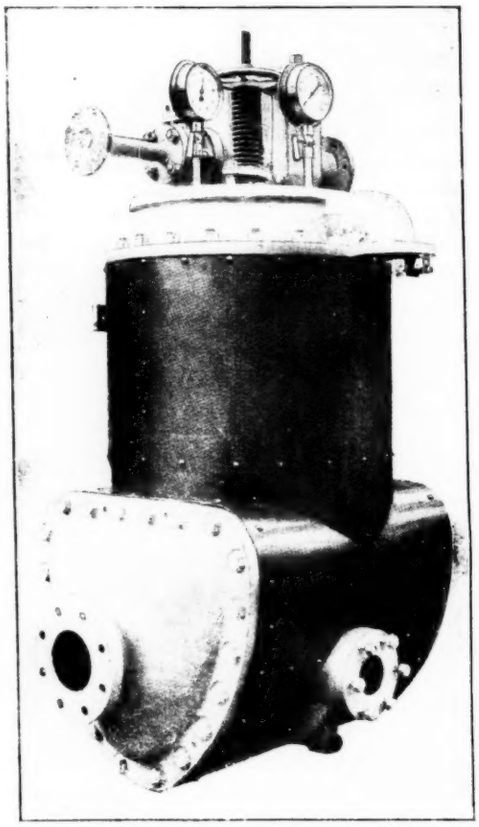


FIG. 2—"CONTRAFLO" DEAERATOR OF EUROPEAN DESIGN

picked up by the feed water, which circulates through the condenser before passing to the deaërator.

Fig. 2 shows a deaërator of the same type, but of foreign design. The American design shown in Fig. 1 differs from this chiefly in the addition of a hotwell cast integral with the bottom of the deaërator shell. This keeps a supply of gas-free water ahead of the feed pumps at all times. A practically constant water level is maintained by a float that controls the supply of water to the spray valve.

*The following articles have so far appeared in the series on feed-water treatment: "Softening Boiler Feed Water with Zeolites," Sept. 12, 1922, "Evaporators in the Stationary Power Plant," Sept. 19; "Corrosion—Its Cause and Cure," Oct. 3; "Corrosion—Apparatus to Prevent It—I," Oct. 24.

Another type of apparatus for removing dissolved gases from feed water is shown in Fig. 3. This is the Cochrane vacuum deaërating heater, an open feed-water heater especially designed to remove the gases in the process of heating the feed water. This is done by maintaining a vacuum in the heater very close to that corresponding to the final temperature of the feed water, and by making provision for bubbling the steam up through the heated water in the storage space.

Where there is plenty of exhaust steam, so that the water is heated practically to 212 deg., the ordinary open heater effects a high degree of gas separation because the solubility of gas in water depends mainly upon what

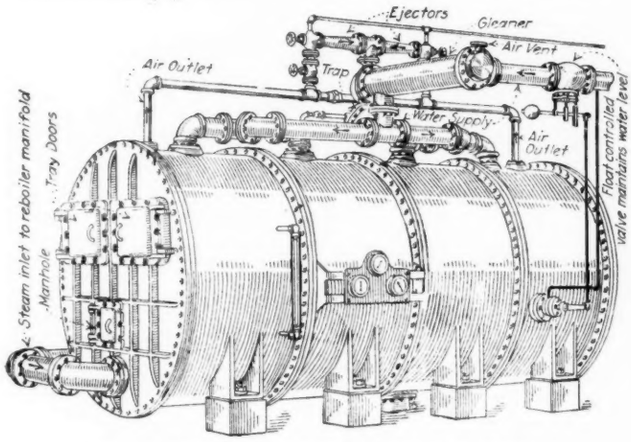


FIG. 3—VACUUM DEAERATING HEATER

is called the "partial pressure" of the gas. This partial pressure is the difference between the total pressure over the water and the vapor pressure corresponding to the temperature of the water, as given in the steam tables.

Where the water is heated to 210 or 212 deg. by exhaust steam, the vapor pressure is nearly equal to the total pressure, so that the partial gas pressure is extremely small, with the result that most of the dissolved gas comes out of solution. A portion of it, however, remains in the form of fine bubbles which cannot ordinarily escape from the water in the short time available.

Effects of Low Feed-Water Temperatures

The recent tendency—particularly in the larger stations equipped with economizers—to reduce the feed temperature well below 212 deg. (by cutting down the amount of exhaust steam from auxiliaries) has resulted in many installations where the open heater must operate at temperatures ranging down to 140 deg. These lower temperatures increase the effectiveness of economizers as far as heat recovery from the flue gases is concerned, but they have the bad effect of reducing the ability of the open heater to remove oxygen and other dissolved gases, so that serious corrosion may result if the oxygen is not otherwise removed. This is on the assumption that the heater operates at or near atmospheric pressure. The amount of dissolved gas is largely determined by the partial pressure of the gas. If the total pressure remains constant at atmospheric, the partial gas pressure must increase by the same amount that the vapor pressure is decreased. The latter, as may be seen from the steam tables, goes down more and more rapidly as the water temperature is reduced.

The deaërating heater here described is provided with an ejector for maintaining a vacuum in the heater corresponding closely to the final temperature of the feed water, with the result that the partial gas pressure—and hence the gas solubility—is close to zero. While this throws practically all of the gas out of solution, some remains entrained in the form of fine bubbles distributed through the water in the storage space. To remove this entrained air, the steam supply is admitted through a perforated manifold, called a "reboiler," located at the bottom of the storage space. The rising steam bubbles "sweep" the air bubbles up into the open space so that the air can be removed by the ejector.

Apparatus Combines Functions of Open Heater and Deaërator

Aside from the addition of these attachments and a "gleaner" (to be described later), the construction is similar to that of an ordinary open heater except that the deaërating heater is designed to withstand a vacuum and to operate on the counterflow principle. In cases where a present feed temperature near 212 deg. may later be considerably reduced—because of the installation of economizers, for example—a heater of this type may be installed without the ejector and gleaner and yet deliver deaërated water at 212 deg. or above, depending on the back pressure carried. This can be done without serious loss of steam to the vent, provided the steam supply is properly regulated. Later the attachments for low-temperature work can be added.

The raw water enters the top of the deaërating heater through distributing pipes and falls over trays to the storage space, the heated and deaërated water being drawn off at the bottom. A constant water level is maintained by a float-controlled valve. The steam, leaving the perforated pipe, bubbles up through the storage water, carrying the entrained gas bubbles up into the open space. The mixture then passes on up through the streams of water falling over the trays until finally

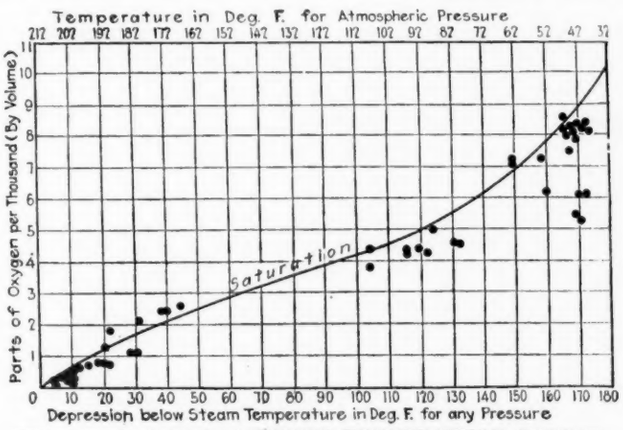

Temperature in Deg. F. for Atmospheric Pressure
212 207 197 187 177 167 157 147 137 127 117 107 97 87 77 67 57 47 37
Parts of Oxygen per Thousand (By Volume)
Saturation
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Depression below Steam Temperature in Deg. F. for any Pressure

FIG. 4—RELATION BETWEEN TEMPERATURE DEPRESSION AND AMOUNT OF DISSOLVED OXYGEN

The curve gives the theoretical amount of dissolved oxygen that can stay in solution in an open heater supplied with steam at atmospheric pressure and heating the feed water to the temperatures given on top the diagram. For pressures a little above or below atmosphere the same curve can be used by entering the lower scale with the difference between the final temperature of the feed water and that corresponding to the total pressure in the heater. The black dots show actual results obtained with ordinary open heaters under various plant conditions.

the air, with any uncondensed vapor, goes out through the ejector.

As the mixture of steam and gas rises through the trays it continually meets colder and colder water, so that most of the vapor is condensed before the ejector

is reached. The weight of gas, on the other hand, increases constantly because the water gives up gas at all stages of the heating process. By the time the mixture reaches the ejector, it contains the minimum percentage of vapor, thus keeping down the necessary size of the ejector and heat-recovery apparatus and reducing the amount of live steam required to operate the ejector.

The heat in the ejector exhaust is recovered by the "gleaner," a small closed heater that returns the heat to the raw water entering the main apparatus. Although the heat in the live steam supplied to the ejector is recovered, it loses availability for power purposes in the process, so that it is well to keep the need for this supply at a minimum.

The curve shown in Fig. 4 is helpful in estimating the gain in air separation that may be expected in changing from an ordinary open heater to one of the deaërating type. It shows the maximum amount of oxygen that can remain in solution if the heater is operated at atmospheric pressure with final water temperatures as indicated along the top. The temperature depressions shown at the bottom are merely the difference between 212 deg. and the upper figures. The lower scale can also be used where the heater pressure is above or below atmospheric, by subtracting the final water temperature from the steam-table temperature corresponding to the total absolute pressure in the heater.

The circles indicate actual results obtained with open heaters of the ordinary construction operating at or near atmospheric pressure under various plant conditions. The oxygen content of the water is given in parts per thousand by volume. This is the same as "cubic centimeters per liter," since there are 1,000 cubic centimeters in one liter.

Relation Between Temperature and Dissolved Oxygen

Since the points obtained with actual open heaters are, on the whole, fairly close to the saturation curve, this curve may be used to estimate the amount of dissolved oxygen to be expected under various conditions with ordinary open heaters. It shows, for example, that the oxygen content, which is only 0.3 part per thousand for a heater raising the feed to 208 deg. at atmospheric pressure, is increased to 3.3 parts per thousand if the feed temperature is lowered to 140 deg. at the same pressure. It should, however, be borne in mind that these figures are only an approximate upper limit.

The deaërating heater, whether operated at atmospheric pressure or not, reduces the oxygen content practically to zero.

The deaërating heater may be fitted into the plant in a number of ways. If the exhaust steam comes from reciprocating auxiliaries, or if for any other reason it is desirable to maintain a pressure above atmospheric up to the heater, this may be accomplished by using an automatic flow valve that will maintain a constant back pressure in the exhaust line, while allowing the absolute pressure in the heater to vary in accordance with the water temperature.

If the type of equipment supplying the exhaust steam will permit it, more complete utilization of the available energy is obtained by giving the exhaust steam free admission to the heater, thus taking advantage of the vacuum.

Another use of a deaërating heater is for the second of two bleeder heaters in an installation where steam is bled for heating the feed water by stages. Again, in cases where exhaust steam is available at atmospheric pressure, while the feed water is to be heated to only 160 deg. or less, use can be made of the intervening temperature drop to produce makeup water in an evaporator, the vacuum deaërating heater serving as the condenser of the last evaporator effect.

Charging a Refrigerating System

By G. Grow

In adding ammonia to the supply already in the refrigerating system, the first step is to provide means whereby the amount added may be determined quickly and accurately. Unless this be done, it is by no means impossible that instead of withdrawing ammonia from the drum, liquid will be forced into the drum from the system. A scale should be placed close to the liquid receiver and the drum placed on the platform and the scale balanced. The drum, still on the scale, should be connected to the liquid line between the receiver and expansion valve. The drum pressure will be the boiling pressure corresponding to the room temperature. If the water is kept flowing over the condenser, the condenser pressure will stay below the drum pressure. The ammonia will then flow from the drum into the line to the evaporating coils.

A second method is to slow down or stop the compressor, shut off the line from the condenser to the receiver and connect the drum to the receiver. The drum will soon be empty as the evaporating coils will take up the ammonia as fast as it leaves the drum. The coil pressure will rise somewhat and this is often objectionable.

A third method is to allow the compressor to run and keep the water flowing freely. The condenser outlet is then closed for a time and the drum valve opened. The ammonia will then flow from the drum until the condenser pressures run up fairly high. When this occurs, the drum valve is closed and the condenser outlet opened. As soon as the condenser pressure drops to normal the operation is repeated. By noticing the weight shown by the scale, one may determine when the drum is empty. To withdraw the charge, the process is the reverse of the charging method. The capacity of the drum should be noted and no greater weight of ammonia should be allowed to flow into the drum.

Corrected Water Rate of Steam Turbine

In the Sept. 5 issue, on page 361, the water rate of the main turbine in the Duratex plant was given as "When operating on steam of 150 lb. gage pressure with 75 deg. superheat and exhausting against a back pressure of 15 lb. gage, is guaranteed to produce a kilowatt-hour on 38 lb. at 500 kw., which is the best rating." This statement should have been, "When operating on steam of 175 lb. gage pressure with 75 deg. superheat and exhausting against a back pressure of 5 lb. gage, is guaranteed to produce a kilowatt-hour on 38.6 lb. at 500 kw. load, which is the best rating."

The flame resulting from the deflagration of pulverized coal differs from that of other fuels in the larger combustion space required on account of its low combustibility, and the higher temperature due to the rapid breaking up of the solid structure of the coal particles. —*American Fuels.*

EDITORIALS

Thermal Efficiencies Sometimes Deceptive

AT FIRST sight it might seem that an increase in the thermal efficiency of any element in a power plant would increase the efficiency of the plant as a whole. That this is not always true may easily be demonstrated. Consider, for example, an imaginary plant containing two condensing prime movers one of which has ten times the capacity of the other. All the auxiliaries in this plant are electrically driven, so that the main condensate passes to the boilers without further heating.

Next, see what happens when the small turbine is changed over from condensing to non-condensing operation in order to heat the feed water up to about 180 deg. with the exhaust steam. The result will be a decrease in the thermal efficiency of the small turbine, accompanied by practically no change in the boiler efficiency or the thermal efficiency of the large turbine. Yet this modification would undoubtedly increase the over-all efficiency of the plant.

This is one case where it is easy to be led astray by the thermal efficiency of a steam turbine or engine. A still more striking example is found where the exhaust is used for process work. Here thermal efficiencies of individual units are practically meaningless.

Many other illustrations could be found, but those given should serve to demonstrate that it is easy to draw wrong conclusions from the thermal efficiency of a steam engine or turbine. The fact is that the formula for figuring this efficiency is based on an assumed layout where the engine can return to the boiler the heat of the liquid at exhaust temperature and nothing more. In the typical modern plant not using process steam, thermal efficiency has significance as applied to the main unit. Elsewhere it is likely to mislead.

In such cases the only safe way to figure the final effect (at the coal pile) of any proposed change, is to make two heat balances, one for the plant before the change and one after.

Auxiliary Turbines for High-Temperature Steam

A NUMBER of large central stations have been built with three hundred pounds steam pressure and two hundred fifty degrees superheat, and even higher pressures have been adopted in a few instances. It is, therefore, timely to consider the effect of such pressures and temperatures on the performance of small non-condensing auxiliary turbines, such as are sometimes used for driving boiler-feed pumps, reserve exciters or other stand-by units.

Even when allowance is made for the external losses, it will be found that a relatively small number of B.t.u.'s are abstracted from each pound of steam passing through these turbines. The exhaust thus has a high heat content which corresponds to a high degree of superheat at the outlet pressure. Since most of these small units govern by throttling, it will be apparent that the conditions are aggravated at light load and higher superheat will exist in the exhaust. For instance, a certain small steam turbine with three hundred pounds gage and two hundred and fifty degrees superheat at the throttle valve and one pound gage at the exhaust, operates with four hundred and twenty-five to five hundred and fifty degrees exhaust temperature, the higher temperature corresponding to low load.

It is generally assumed in engineering practice that cast iron is not a sound material to use where steam temperatures exceed four hundred and fifty degrees Fahrenheit, as growth sets in over a period of time and causes a weakening of the metal as well as misalignment of parts. It is, therefore, essential for safety and reliability that the casings and all parts of such turbines coming in contact with exhaust steam shall be of cast steel, and furthermore, that all fittings, valves, etc., in the exhaust lines shall also be of cast steel. This change will increase the cost of such units and piping systems and will necessitate the redesign of many of the small turbines on the market to fit them for this class of service.

Another difficulty arises when such highly superheated exhaust steam is used in closed heaters. It is well known that highly superheated steam has a low coefficient of heat transfer. Hence, much larger heater surfaces must be provided in such closed heaters to desuperheat and condense the steam than where saturated exhaust steam is used. Where this has not been considered, the closed heaters have often been found to be inefficient and lacking in capacity.

If safe, reliable equipment is desired for steam auxiliaries in plants using high-temperature steam, the points discussed in the preceding paragraphs will repay careful consideration.

Ground Connections Should Be Given Careful Attention

IN THE installation and operation of electric equipment an important detail is proper and effective ground connections. The absence of these constitutes a hazard to life and property. If the frames of machines and metal parts of the building are not effectively grounded, there is always danger of these parts coming in contact with some high potential circuit and no one knowing it until they are touched by somebody in contact with the earth and serious injury or death results On the other hand, owing to lack of proper ground connections stray currents have caused serious corrosion of machinery parts. Many a power-plant engineer has wondered why the condenser tubes, pump impellers or other parts of the plant equipment pitted or corroded so fast, when the real cause was his own negligence in maintaining proper earth connections.

Unlike almost any other part of the electric circuits or equipment, a neglected ground connection does not give any trouble until called upon to take care of the emergency for which it was installed. If a power line becomes open-circuited, the failure of the equipment

to function as it should, immediately brings the defect to the attendant's notice. Likewise, a short-circuit causes the protective device to open and draws attention to the fault. Not so with ground connections. These connections may be made properly when the plant is built, but owing to corrosion or mechanical injury, in time may become open-circuited or of high resistance without its being discovered unless it is made a part of the regular operating routine of the plant to inspect and test these connections at regular intervals. No system of inspection and maintenance can be considered complete that does not give careful attention to this.

The question of when and how to ground electrical equipment is covered in the National Electric Code, and in this issue is the first of five articles dealing with the subject as interpreted from this Code. These regulations, although promulgated primarily for preventing electrical equipment and circuits from creating a fire hazard, are also safety regulations. If ground connections are made and maintained according to these requirements, the hazard to life and property will in most cases be reduced to a minimum.

Where the frames of electrical equipment are grounded and the circuit is grounded, there is the danger of being shocked by touching a bare part of the circuit and the frame. Under this condition the grounding of the frame increases the liability of being shocked and has been used as an argument against grounding. On the other hand, with the frame insulated there is probably less liability of shock when working around the equipment, but should the insulation break down at some point within the machine, then there is the danger of someone getting between the frame and the earth and being subjected to the potential of the line to which the machine connects, the difference being that those working around the machine should know the conditions and take the proper precautions, where one who might accidentally touch the frame of the machine might be totally ignorant of any danger. For this reason the Code requires that the frames of all equipment operating on voltages of one hundred and fifty volts and higher, if accessible to others than qualified persons, must have their frames permanently and effectively grounded.

What Factors Justify Multiple Sources of Power

CONDITIONS governing the choice between a single or multiple source of power for a manufacturing plant have received little or no general discussion. A field of many problems and widely varying conditions presents itself, where solutions are being formed and put into execution continually, yet about which there is very little recorded as to the reasons guiding the selections and the degree of economical success attained.

Attention is drawn to this in a paper read recently before the Springfield, Mass., meeting of the A.S.M.E., by R. A. Packard, an abstract of which appears in this issue. Multiple sources of power for the system described arose naturally from the utilization of one steam and two hydro-electric plants. The advantages derived, however, from the viewpoint of reliability and service continuity were notable.

A multiple power source is not justified in many instances. A small plant with uses for steam, but having no process vitally dependent on service continuity, would naturally install steam prime movers with arrangements for using extracted or exhaust steam. An emergency tie line to an outside source of power supply would not be necessary in a properly designed and operated installation for such service, although if a tie line could be maintained practically without appreciable cost, it would be desirable. In a large industrial plant, with many employees and large investment tied up in machines and materials, a stand-by connection to an outside power source sometimes is a necessity, especially for processes where a service interruption would produce a comparatively heavy loss, such as that of a steel mill. On the other hand, where such a mill operates from a public service system, a private plant for auxiliary service, such as for supplying cranes, is often desirable. For instance, in an electric furnace installation it would be possible to pour a charge and prevent damage to the furnace, on failure of the main power supply, by using auxiliary power in handling the ladle and in dumping.

It is difficult to conceive of service requirements that would make two steam plants preferable to one, in view of general plant economy increasing with size. Public service corporations, however, in some cases have located new plants with this principle in view, so that cutting the connecting lines inconveniences the main system as little as possible. With gas engine plants, however, maximum efficiency depends more directly on the size of the prime mover than on that of the entire plant, and since the largest commercial size is one-tenth that of the largest steam-turbine unit, multiple gas plants would therefore appear justifiable for service continuity to a much greater extent. When it is recalled that a large steel plant may use in the neighborhood of 100,000 kilowatts, and overhead power lines are liable to the contact of locomotive cranes, it would not be surprising if the principle of widely separated multiple plants were to find a definite and specific application.

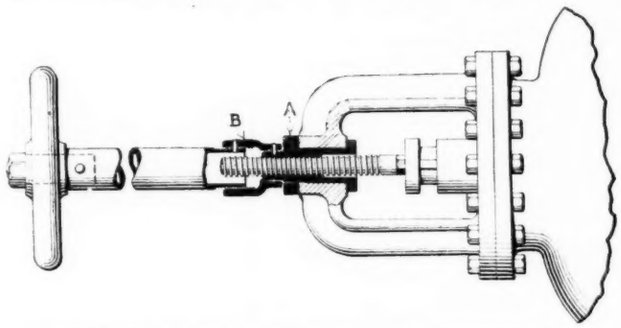
In summing up the situation, there appears to be three general classes of factors involved in number and locations of plants: Those referring to power generation, including fuel, water, reservoir capacity, labor, etc., and station reliability; those dependent on transmission, involving cost of various types of lines and likelihood of trouble from internal or external sources; those of manufacturing, involving size and distribution of the mills, comparative cost of shutdown periods and direction of future expansion. The paper by Mr. Packard deals with these factors and their solution. Other instances would be valuable for comparison, such as that where a close decision is required or where the principle of multiple power sources is clearly proved from factory requirements at the expense of plant efficiency.

"A Persistent Shortage in Unskilled Labor," says a headline in one of our contemporaries. Well, what of it? We in America are noted for the extensive use of power in place of human labor. If we are to advance, we must make greater and greater use of our natural power resources; if we are to maintain our reputation for invention, we must create new mechanical means for multiplying production. Our supply of unskilled labor depends upon our immigration policy; if immigration falls off, a shortage in the kind of labor needed to do the "rough work" of industry must surely result. But it is inconceivable that American inventive genius will not rise to the occasion, once the labor situation becomes acute—so why worry?

PRACTICAL IDEAS from PRACTICAL MEN

A Practical Extension for Small Valve with Rising Stem

It is often necessary, from the viewpoint of safety or convenience, to have an extension on a valve stem. In many instances the ordinary forked rod is not satisfactory. In the illustration is shown an extension made of pipe and installed on a 2½-in. gate valve of the out-



EXTENSION IS MADE OF PIPE AND CONNECTED TO BUSHING BY A REDUCING COUPLING

side screw-and-yoke type. To install this extension, the handwheel is removed and a ¾-in. pipe thread is cut over the locknut threads on the bushing. The collar *A* is then put on in place of the wheel and held in place by a 1x¾ reducing bushing *B*. A piece of 1-in. galvanized iron pipe is then cut the required length, and the handwheel is secured on one end. The other end of the pipe is threaded and screwed tightly into the bushing and then pinned. If the extension is of considerable length, it may be necessary to support the pipe with a suitable hanger.

With an extension of this kind the stem is protected from dust or dirt, when the valve is in the open position.

JOHN V. EMERY.

Struthers, Ohio.

Improving the Insulation of Gas-Engine Igniters

The insulation of gas-engine igniters is invariably built up of mica washers, which are punched out of sheet mica and inserted in the igniter plug, as shown in Fig. 1. Although mica is a first-class insulating material and the washers are firmly pressed together by tightening the nut on the electrode, these insulators are not reliable and frequently break down.

The failure of this type of insulator is undoubtedly due to the outer surface not being properly finished to a high polish, which allows the oil to creep in between the washers and deteriorate the mica.

A better method of making the insulators is to make a drill gig of two bars of metal fitted with drill bushings and clamp a sufficient number of pieces of the mica sheet together and drill all the holes in one operation; then remove the drill gig bushing and insert the metal bushing *A* and draw the locknut up tight before removing from the gig. Then place the insulator on a mandrel and turn to a taper, as shown in Fig. 2. An insulator of this type has a long life and is reliable.

It is advisable to lubricate the movable electrode with a few drops of oil, but the stationary one should be kept entirely free of oil and dirt. It is also a good

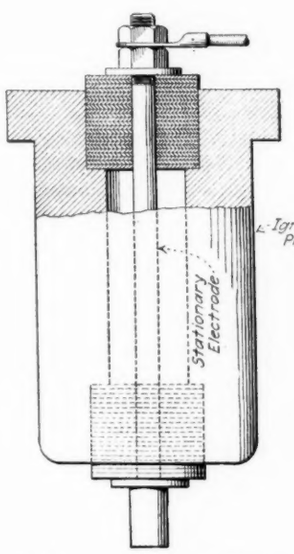


FIG. 1. OLD METHOD OF INSULATING ELECTRODE

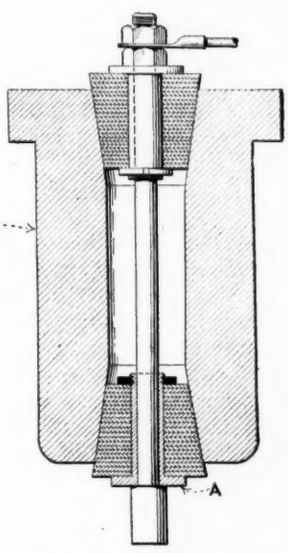


FIG. 2. IMPROVED TYPE OF INSULATOR

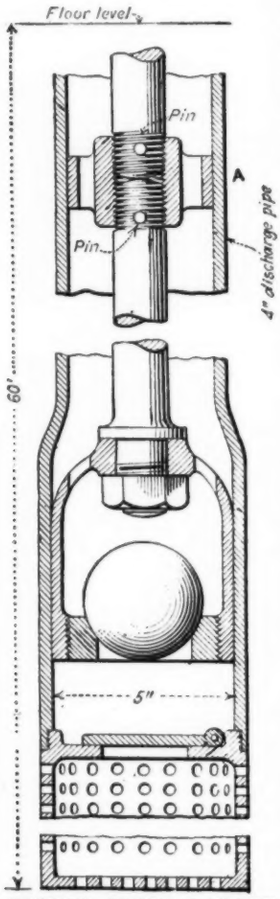
plan to remove the insulators from time to time and wash them with gasoline, to free the mica of any oil that may have carried over from the engine.

Schoonhoven, Holland. H. WIELAND LOS.

Experiences with a Deepwell Pump

In a building on the lower west side of New York City water was furnished to tenants and manufacturing companies from a tank on the roof supplied from an artesian well and pumped by a duplex steam pump, the water level ranging from 8 to 12 ft. below the pump.

When the Seventh Avenue subway was under construction, large pumps were installed at Canal St., which lowered the "water table" in the district south of Canal St. and west to the Hudson River to such an extent that we were obliged to install deepwell pumps or abandon the wells. The pump purchased for use in our building was of standard make and electrically driven. On being started up, it ran beautifully, keeping up the water supply at about half speed of the motor.



BARREL BEING LARGER THAN DISCHARGE PIPE, MADE REPAIRS DIFFICULT

After a few weeks it was necessary to increase the speed, and later the pump had to be operated at full speed. At the end of ten weeks an adequate supply of water could no longer be obtained and the pump had to be examined. It was then discovered that the barrel was 1 in. larger than the discharge pipe, so in order to get at the plunger, all the pipe had to be withdrawn from the well and the plunger rod disconnected at each joint at the same time. Owing to the small amount of headroom, the pipe was in 12-ft. lengths. The frame and foot plate carrying the crankshaft and motor had first to be moved back two feet to clear the well pipe. When the pump barrel was opened, it was found that the brass ball-valve in the plunger had several "flats" worn on it and that it was badly scored by sand. It required the labor of three men, one day, to remove the pump from the well; then there was a delay of five days in getting a new valve, and another day to replace the pump. In the meantime 25,000 gal. of city water had to be pumped to the tank, as the city pressure would not raise the water above the fourth floor. The pump then ran all right for about three months, when the same job had to be done over again. This time a cast-iron ball was made and casehardened; this lasted much longer than the brass ball. Trouble was also encountered with the plunger-rod unscrewing from the guide couplings. The pump was again dismantled and the rod and couplings drilled and pinned, as shown at *A* in the cut. In nine months the pump was dismantled for repairs four times. It would seem that a pump of this type might be built so that the plunger could be withdrawn through the discharge pipe. It would save considerable in the cost of repairs without materially reducing the capacity of the pump. M. M. BROWN.

Camden, Me.

Connecting One Lubricator for Two Steam Pumps

Two duplex steam pumps were recently installed in a pit adjoining a mine, to discharge the water that accumulated from underground sources. The pumps are used alternately—week about. As only one lubricator was available when the pumps were installed, it was connected on the main steam line and used for both pumps, the connections being originally arranged as shown in Fig. 1.

The right-hand pump was first put in service. During the week's run of this pump the lubrication was ample. But when the left-hand pump was started for the next week's run, trouble immediately ensued. The pump had been in operation only a short time when the steam pistons began to groan for want of lubrication, and before the day was out the pump began sticking on the centers, necessitating frequent prying of the crossheads to keep it going. In the meantime the lubricator was working steadily. The engineer concluded that the drops of oil, instead of making the right-angled turn with the steam at *A*, were precipitated into the section of pipe between the tee and the valve *B*. He disconnected the union at *C*, opened the valve *B* and found

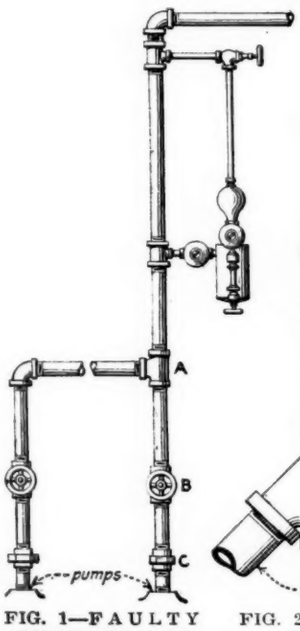


FIG. 1—FAULTY CONNECTION OF LUBRICATOR

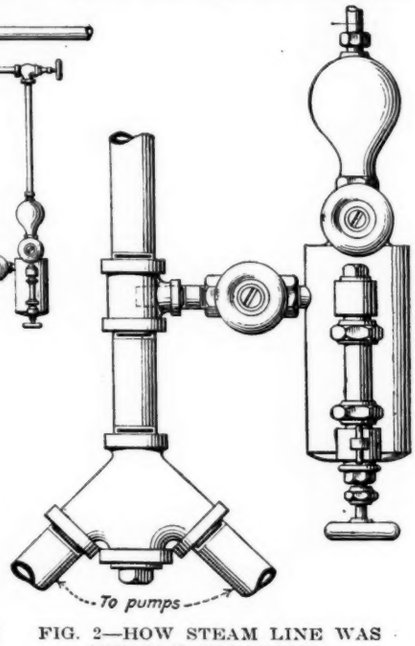
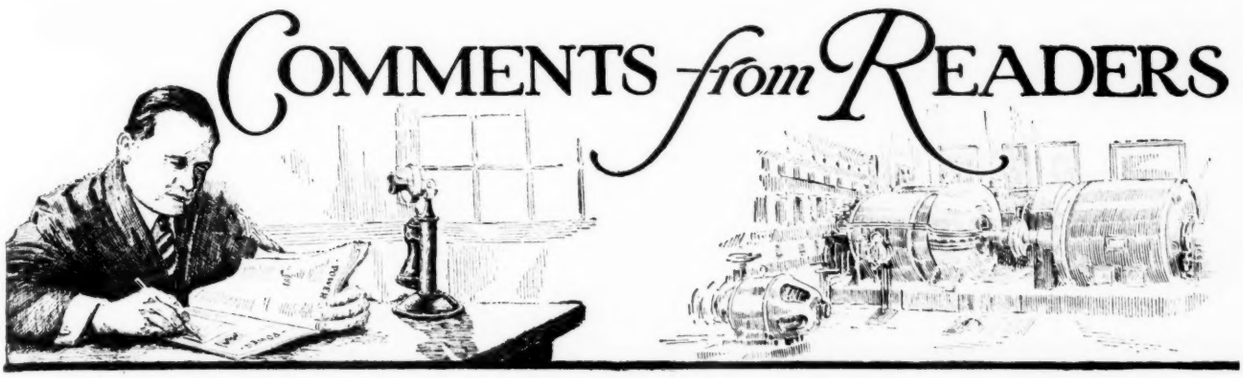


FIG. 2—HOW STEAM LINE WAS FINALLY CONNECTED TO PUMP

that his surmise was correct; more than a pint of oil was drained from the pipe.

The trouble was corrected by arranging the piping as shown in Fig. 2. The lubricator is connected to the steam pipe just above the Y, the connection being extended inside the pipe, as indicated by the dotted lines, so that the drops of oil are released at the center of the pipe. Thus the oil is swept through the branch of the Y which leads to the pump in use. No further trouble was experienced from lack of lubrication in the pump.

St. Louis, Mo. A. J. DIXON.



Justifiable Coercion

Many articles have been published from time to time similar to the one in the Oct. 17 issue on "Justifiable Coercion," in which attention is called to the fact that engineers and plant owners object to boiler criticism. I believe this expresses only the opinion of the minority. In our own plant here, and I believe in the majority of plants in the country, the elevator, boiler or general inspectors are looked upon as a decided asset to the institution. They are always received here with a hearty good will. So far they have never made a recommendation that was not justified, and they always approach us with a whole-hearted helpful spirit.

In my opinion these men are much above the average in intelligence and have directed their minds along the lines of their chosen work. They seldom visit our plant that they do not show that they are interested in improving our methods of operation and their suggestions are always well received.

My advice to all power-plant operators is to "warm up" to the inspector. He has a lot of helpful information that travel and observation have given him, that he is willing to impart to engineers who approach him in a right manner.

L. C. TROW,
Supervising Engineer Mayo Clinic.
Rochester, Minn.

A Peculiar Design of Air Compressor

In the Oct. 3 issue Mr. McLaren raises a point as to the use of certain passages found in the cylinder of an air compressor, a section of which is shown in Fig. 1.

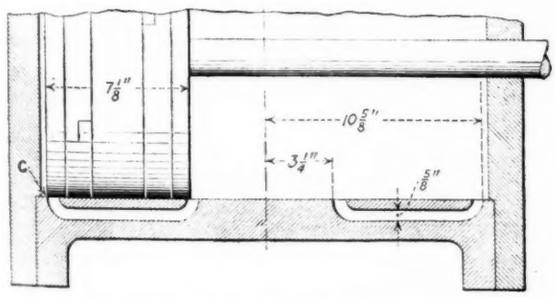


FIG. 1—SHOWS LOCATION OF PORTS IN COMPRESSOR CYLINDER

These are probably "flash ports" placed in the cylinder with the idea of reducing the pressure at the start of the stroke by allowing the air trapped in the clearance space to flash around the piston. The net effect is a gain in volumetric efficiency with a loss in power normally returned to the piston.

Indicator diagrams with and without these ports would appear as shown in Fig. 2. The solid line shows the re-expansion line without the ports, and the dotted

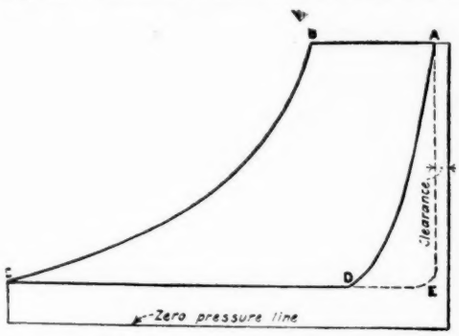


FIG. 2—INDICATOR DIAGRAMS WITH AND WITHOUT PORTS

line indicates the rapid drop in pressure with "flash port." The gain is one in theory mainly and therefore not used to any extent.

PAUL A. BAUMEISTER.
Flushing, N. Y.

R. McLaren, in *Power*, Oct. 3, asked the reason for the bypass ports in the clearance space of his air compressor. These are undoubtedly an adaptation of the Weiss bypass used in condenser dry-vacuum pumps. The purpose of this bypass is to prevent re-expansion of air in the clearance space and to increase the volumetric efficiency of the compressor at the cost of a slight decrease in mechanical efficiency.

With the ports open the diagram obtained would be shown by the lines *CBAE* in the illustration, whereas with the ports plugged the diagram would follow the lines *CBAD*, and the volumetric efficiencies under the two conditions would be proportional to $\frac{CE}{CD}$.

To make this port arrangement advantageous, the air compressor should be equipped with mechanically operated valves and these should be set so that the suction valve would close just an instant before the port was uncovered, as in this way the air under pressure in the clearance space would go to increase the pressure in the opposite end of the cylinder a slight amount and a portion of the energy saved instead of being largely wasted owing to slow closing of automatic inlet valves.

Arrangements of such ports are more advantageous with high ratios of compression and large clearance

volumes, particularly where the compressor is not to be used steadily, as they enable the maximum capacity to be developed on a minimum-sized machine at the expense of a slight loss in efficiency. This loss of efficiency is not as serious as might appear offhand, for while the power input of the machine is increased from area *ABCD* to area *ABCE*, the output is increased in the ratio *CE* to *CD* so that the relative efficiency will be $\frac{CE}{CD} \times \frac{area\ ABCD}{area\ ABCE}$.

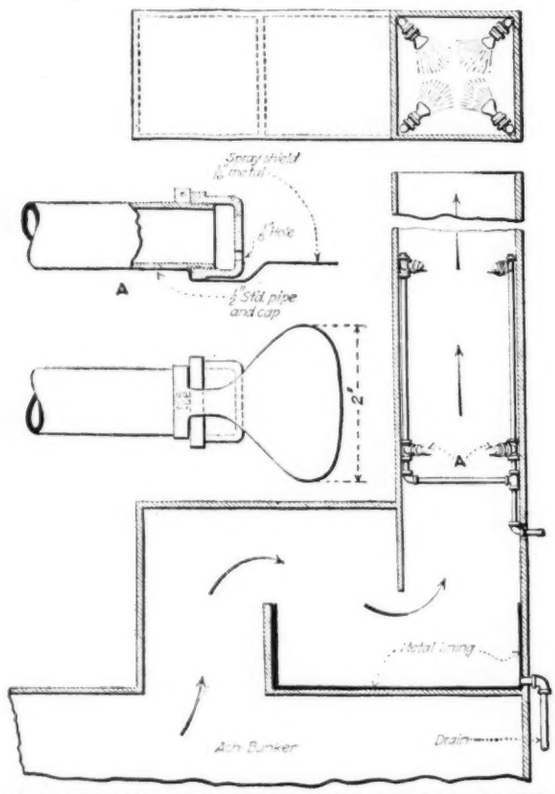
H. D. FISHER.

Swarthmore, Pa.

Eliminating Ash Dust with Jet Conveyors

With reference to the letter by W. B. Trott in the Oct. 10 issue, we have effectively overcome the dust nuisance by installing sprays in the vent as shown in the illustration.

An offset is made in the vent, which is built of 1-in. lumber, and a metal-lined catch basin is placed at the bottom to catch the drip from the sprays and prevent



EIGHT SPRAYS ARE LOCATED IN VENT PIPE WITH CATCH BASIN AT BOTTOM

it running into the bunker. The size of the vent is not given, as this depends upon the amount of steam used, but it must be large enough to keep the steam velocity low.

If the quantity of steam used is relatively small, four spray nozzles may be sufficient, but we have had best results by using two groups of four each as shown. The effectiveness of a wash system of this type depends upon the character of the spray, which, to give best results, should be a sheet of water. At *A* is shown a detail of the spray, which is made by drilling a $\frac{1}{8}$-in. hole close to one side of the pipe cap and clamping a shield on the pipe to spread the spray.

Battle Creek, Mich. P. T. WOODWORTH.

Some Important Factors Neglected

Much has been written regarding boiler plant operation and construction, but until recently care in the design of furnaces has been sadly neglected. Even today the design of furnaces for the proper combustion of fuel is a more or less rule-of-thumb practice based somewhat on experience. While empirical methods are often satisfactory and in many cases superior to a strictly theoretical consideration in the combustion field, many of the methods are improper interpretations of past experience. Those in charge of plants have virtually considered the furnace a minor feature. This is due to a lack of understanding of the problem more often than to an attempt to slight the question.

Today there is a tendency toward fads in furnace construction and fuels. There are powdered-coal advocates, fuel-oil faddists and those who put their trust only in solid fuels. Each of these fuels may be used successfully in any plant regardless of size if properly considered.

Among the powdered-coal enthusiasts the statement is often repeated that such fuel is suitable and successful only in boilers of large size; whereas, as a matter of fact, powdered coal may be burned efficiently in units as small as 1,500 sq.ft. heating surface. By efficiently I mean to consider the cost element of fixed charges and operating cost as well as the mere thermal results.

MECHANICAL AND STEAM ATOMIZATION COMPARED

The fuel-oil proponents are divided into two camps, mechanical and steam atomization. There are advantages to each type of burner, and the proper equipment must be selected with relation to the operating conditions for each particular installation. The foremost consideration is the operating load schedule. Boiler loads must be considered in somewhat the same manner as the electrical loading of generators, and boilers cut in and out accordingly. Where boiler units can be operated at a certain rating continuously, the mechanical burner will show certain advantages in increased thermal efficiency, though this may be offset in a small unit owing to the higher investment and maintenance charge. Where the load on the units is variable, the mechanical burner is at a disadvantage since, in the writer's opinion, it will not atomize the oil properly at less than full capacity. Often there is not room at the furnace front to install enough burners of the mechanical type to take care of the extremely variable rating. On the other hand, a steam-jet burner properly designed and installed is capable of handling large variations in output while maintaining proper atomization.

For marine practice or in cases where makeup water is expensive the mechanical burner is best if load fluctuations can be taken care of. Both types have their place and due consideration should be given them in determining which to install. With either type of burner small orifices should be avoided owing to a tendency to clog, and means should be provided for blowing all the oil out of the burner when cutting out, as otherwise carbon of a tenacious nature will be deposited on account of reflected heat from the furnace falls. The common needle valve for regulation should be avoided on account of its narrow circumferential passage. A valve with a wide and short slot is more practical. The orifice should be readily renewable,

accessible for cleaning and adaptable to change in flame shape to suit any changes that may be made in the furnace proportions. There appears to be no limit to the size of boilers that may be operated with oil except that the small vertical or firebox type boilers do not have sufficient combustion space.

The use of coal, hand or stoker fired, has resulted in attempts to mix the gases for better combustion or smoke elimination by building all manner of grotesque bridge walls and the use of steam or air jets over the fire. While these expedients have accomplished the purpose after a fashion, the wasted fuel due to some of these designs is enormous.

Other fuels have not been considered here owing to their special nature and limited application.

It is desirable to point out some conditions that have grown up with the boiler-construction industry and that have never been corrected. When the shell-type boilers were first installed, they were lug set and these lugs transferred the boiler weight directly to the brickwork and over a limited area. This loading has been the greatest factor in the high maintenance and lack of durability of furnace settings. Today with suspended settings for tubular and water-tube boilers the steelwork is so light in the majority of cases that the brickwork must act as a stiffener, an office that never should have been required of it. The heavy maintenance of walls in most cases has been accepted as an inherent feature of boiler installations without investigation as to the cause of such failures.

Structural Supports Must Be Rigid

To bring furnace design to a proper basis, it is first necessary to build boilers with structural supports sufficiently rigid to eliminate any strain whatsoever upon the brickwork. Then the outer common brickwork must be set independently of the firebrick lining and not keyed into the outer wall as is too often the case. Some may claim that under such a condition the firebrick will not stand up, but if the steel structure is sufficiently rigid the elimination of such keys will result in longer life to the entire brickwork. Practice in which the foregoing elements have been properly taken care of, have demonstrated this fact.

Furnace volume is an element more often neglected than considered. It appears to be a follow-the-leader game in determining the proper volume. In general the volume has been too small rather than too large. The constructor should be cautioned not to swing to the other extreme and make the furnace too large, or losses will pile up, rendering efficient operation impossible.

The proper design for all fuels is a clear and unobstructed combustion space, eliminating all mixing arches. Ignition arches and sufficient brick area in the proper place are needed for igniting the fuel. The latter are essential and should be properly designed with regard to quality and quantity of fuel to be burned. Such brickwork is even more important with powdered coal and oil. The construction need not be elaborate—the simpler the better, with due regard to the fuel to be burned.

The question of baffles in water-tube boilers is one that cannot be fully considered in an article of this length, and to consider the subject lightly would be dangerous. The principal features for consideration are: (1) Location so as to be readily accessible for replacement and repairs; (2) designed to eliminate warping; (3) to have vertical baffles of sufficient strength to withstand the column loading effect and any jar when a baffle part breaks and the others drop in position; (4) to cover as little of the tube as possible; (5) placed to eliminate the lodging of soot; (6) sectional, damaged parts readily removable; (7) removable without tearing down furnace walls.

Special refractory bricks have been used in boiler-furnace construction, and while these forms find success in electric-furnace construction, they are not necessary in boiler furnaces. These specials are very sensitive to sudden changes in temperature, and as a consequence maintenance is high. Many of these materials were brought into the market to eliminate heat losses that were properly due more to mechanical failure than to a lack of heat resistivity of the fireclay and common brick.

The study of boiler furnaces with some few exceptions has been superficial and built around the sale of "perfected" materials and new ideas. While we are requiring high efficiency from our turbines and generators, why not give consideration to furnace construction, the cause of much waste each year?

Chicago, Ill. HUGH E. WEIGHTMAN,
Consulting Engineer.

Why Blame the Operator?

In *Power*, Oct. 3, an article appears, entitled "Chasing Oil Engine Troubles," the reading of which left one pondering over the lack of charity we sometimes exhibit one to another. The writer of the article condemns the average engineer for his want of reasoning power and unwillingness to learn the why and wherefore of the causes that lead to trouble with Diesel engines.

In the instance cited, why blame the engineer in charge for the trouble, when it was clearly proved that the direct cause (a simple one) of all the bother was a ball of solder left in the air line by the erecting engineer? The writer does not say whether he was that erector or not. The next to last paragraph of the article states that "the engineer was not responsible for the burning of the first flame plate nor for the first case of preignition, but he should not have permitted these to occur a second time." Yet we find the trouble man states that after diagnosing the case, he put in a new flame plate and after running for some time, found the new flame plate with one hole burned in it. One might criticize the attitude of the erector at length, but one more point will suffice. Why was an indicator not used the first night? That's the first thing a steam engineer would have done with a steam engine if pounding was going on and the bearings were known to be in good order.

The company that employs this trouble man evidently expects to have some difficulties in the running of their engines or else they would not require his services. So he should encourage the operating engineers instead of blaming them for being unable immediately to detect engine troubles that apparently stung the erector until he had investigated the situation.

Vancouver, B. C. JOHN MELVILLE.

A 30,000-kw. G.E. turbo-generator is being installed at the Lakeside plant of the Milwaukee Electric Railway & Light Co. This brings the capacity of the plant up to 70,000 kw.—200,000 kw. ultimately will be installed. The plant was described in detail in the Apr. 18 issue of *Power*.

QUESTIONS AND ANSWERS

Requirement of Greater Stack Capacity

We have a 30-in. diameter steel stack 68 ft. high in good condition at present, used on a smaller boiler which we are to replace by a 72-in. diameter by 18-in. h.r.t. boiler containing seventy 4-in. tubes. Would this stack be large enough by adding to its height? P. C. Q.

The cross-sectional area of the present 30-in. diameter stack is 712.76 sq.in., whereas for a stack 60 to 70 ft. high it is customary to employ a stack area equal to the combined area of the tubes. The standard size would be 34 in. diameter or 907.92 sq.in. area by 60 ft. high. Stack capacity is directly as the area and as the square root of the height.

The capacity of the 30-in. diameter by 68-ft. stack to that of the 34-in. diameter by 60-ft. stack would be as $712.76 \times \sqrt{68}$ to $907.92 \times \sqrt{60}$ or as 5,877.41 to 7,032.75. Hence the 30-in. stack should have its capacity increased $(7{,}032.75 - 5{,}877.41) \div 5{,}877.41 \times 100 = 19.6$ per cent. If the height of the old 30-in. stack is to be increased to give the same draft capacity as a 34-in. by 60-ft. stack, the old stack should be $(1.196 \times \sqrt{68})^2 = 98.62$ ft. high or $98.62 - 68 = 30.62$ ft. higher than the present height of 68 ft.

Warm Cooling Water for Carbon Dioxide Refrigerating Plant

We have a carbon dioxide refrigerating system, but in order to get its rating, must run the compressor at twice its normal speed. The condenser pressure is 1,100 lb. per sq.in., the coil pressure 300 lb. and the cooling-water temperature from 77 to 87 deg. F. on and 110 deg. off. What is wrong? P. G. R.

It is necessary to have a temperature drop between the carbon dioxide in the condenser and the cooling water in order to cause the heat to flow from the hot gas to the water. This temperature difference would probably be in the neighborhood of 10 deg. Taking the high value given—namely, 87 deg. F.—the temperature in the condenser would then be 97 deg. F. This is above the critical temperature for carbon dioxide. By critical temperature is meant the temperature at which carbon dioxide gas will not liquefy into liquid carbon dioxide, no matter how high the pressure is that is placed on the condenser. This critical temperature is in the neighborhood of 86 to 87 deg. F., and if your carbon dioxide gas is at a higher temperature, you will not be able to condense it. Under these circumstances the only thing that goes through the receiver and expansion valve into the evaporating coil is carbon dioxide gas. The cooling effect that you do obtain is due to the temperature drop caused by the expansion of this gas from 1,140 lb. to 300 lb. Incidentally, this is a small percentage of the refrigerating effect that you would be able to obtain if liquid carbon dioxide were passing through the expansion valve and boiling in the evaporating coil. It is quite possible that you have some liquid carbon dioxide going to the receiver and through the expansion valve to the evaporating coil, for the reason that the gas drops below the critical temperature, and the temperature drop causes some of the gas to condense, say 20 per cent.

The result of the high cooling-water temperature is that your plant capacity is reduced, and to offset this, the compressor speed must be increased to handle a larger volume of gas. The solution is to find a cooler condenser-water supply. You should have it at least below 75 deg.

Wire Wound Coils on the Rotors of Induction Motors

What advantage is obtained by increasing the number of turns in the rotor of a wound-rotor induction motor? In the older types a few turns made of copper bars were in common use on the rotor. Today a number of turns of small insulated wires are used in both domestic and foreign motors. Windings of this kind cost more to make, they require more slot space and they obstruct the ventilation space at the ends of the motors. But besides this they increase the impedance of the motor which tends to reduce the current and thereby the torque of the motor. J. B. O.

Increasing the number of turns in a wound-rotor induction motor is an advantage for several reasons: First, it increases the voltage between collector rings and decreases the current. This makes possible collector rings and brushes of a smaller capacity, which is some advantage on the motor, but mainly it considerably simplifies and cheapens the control, as the providing of cast-iron grids or other forms of resistance increases when the current exceeds a certain value. The minimum limit to this is when the cross-section of such grids is as small as it can be made for mechanical strength, and there is no advantage in reducing the current below that point.

Contrary to the foregoing opinion the wire winding actually costs less than the old bar winding and is much more satisfactory. The old bar and connector winding required that the end connectors be punched from sheet copper and bent to shape, involving fairly expensive equipment in the way of tools for dies and benders. Also a winding for a different number of poles required a different throw of the connector on the ends, which greatly increased the investment in tool equipment. Further, the so-called involute end connectors lie in a radial plane and it was very difficult

to clamp them mechanically and prevent their chafing and breaking due to fatigue when subjected to the shocks of gearing or other forms of coupling which set up vibration.

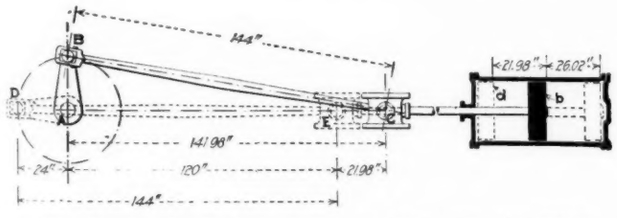
Referring to the statement that the impedance is increased, this is not true except to a very slight extent. Since an induction motor is like a transformer, the impedance of the rotor is a question of ampere turns and not of turns alone. In other words, if one had 100 amperes passing through ten turns it would be the same impedance as 1,000 amperes passing through one turn. Hence the impedance with the bar and connector winding and with the wire winding is almost identical, or at least so near the same that for all practical purposes the torque and other performance of the motor would not be affected. In considering this question of impedance, it should also be remembered that the frequency in the rotor is very much lower than that in the stator, being practically zero at synchronous speed.

From the foregoing you can see that there are a number of very good practical reasons why a wire winding is preferable to a bar and connector winding, especially on small motors. On relatively large motors where a sufficiently high voltage can be generated with a comparatively small number of turns and the coils are made of fairly heavy strap, one has the advantages of both types of windings. The fact that practically all manufacturers of induction motors have come to this same conclusion and are using wire-wound coils instead of bars and end connectors demonstrates that from the viewpoint of economy and superiority the higher voltage winding is preferable.

Percentage of Stroke for Crank on a Quarter

What per cent of stroke of the piston is completed from the crank end, or from the head end, when the crank is on a quarter, if the stroke of the engine is 48 in. and length of connecting rod 12 ft.? J. C. S.

The length of crank would be $\frac{1}{2}$ of 48 = 24 in., and length of connecting rod 12 × 12 = 144 in. When the piston is in the crosshead end of the cylinder at *d*, and the crank is on the center *D*, as shown in the sketch, the distance from the center of the shaft *A* to the



PER CENT OF STROKE WITH ENGINE ON QUARTER

center of the crosshead pin, then at *E*, would be 144 − 24 = 120 in. When the crank is on a quarter, as at *B*, its center line *AB* is at right angles with the cylinder center line *AC* and the connecting-rod center line *BC* forms the hypotenuse of a right-angle triangle *ABC*, wherein

$$AC = \sqrt{(BC)^2 - (AB)^2},$$

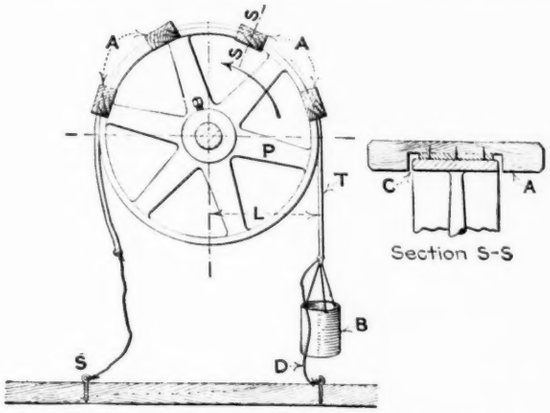
or $$AC = \sqrt{(144)^2 - (24)^2} = 141.98 \text{ in.}$$

Hence for movement of the crank from the dead center *D* to the quarter position *B* or opposite quarter, the center of the crosshead pin would be moved from *E* to *C*, or 141.98 − 120 = 21.98 in., and the piston would have moved the same distance *d* to *b*, or (21.98 × 100) ÷ 48 = 45.79 per cent of the stroke. For a stroke from the head end and the crank on either quarter the piston would have moved 48 − 21.98 = 26.02 in., or (26.02 × 100) ÷ 48 = 54.21 per cent of the stroke.

Strap Brake for Testing Power of Small Gas Engine

How can a brake test be made of a small gas engine that develops about one-half of one horsepower, running about 300 r.p.m.? S. C. M.

A simple form of leather strap brake for testing the power developed by a small motor is shown in the illustration. A piece of flexible leather belting



STRAP BRAKE FOR TESTING SMALL MOTORS

is thrown over a pulley *P* of any convenient size, secured on the shaft of the motor. To prevent the belt from sliding sideways off the face of the pulley, it may be tacked fast to light notched cleats of wood *AA* that allow a little clearance at the edges of the pulley rim as indicated in the cross-sectional view at *C* With rotation of the pulley in the direction indicated by the arrow, the tendency for the belt to become wound on the pulley is resisted by placing sufficient shot or other convenient weights in a bucket *B* attached to the side *T*. As a precaution against accidents the ends of the belt are secured to the floor at *S* and *D* by light but strong, flexible cords. Both cords must be slack when the gross weight *B* has been sufficiently increased to reduce the speed of the motor. When the cleats and ends of the belt are in such positions that they would have no tendency to turn the pulley in either direction then, when the motor is running, the power developed in just sustaining a weight *B* with slippage of the belt on the pulley would be the same as though the same total weight were being raised by the belt winding on the pulley when making the same r.p.m. In operation of the brake, increase the friction by adding equal weights to opposite sides of the belt, or to reduce the friction, lubricate the face of the pulley.

If the distance *L* represents the radius of the pulley plus one-half the thickness of the belt, in feet, then without slippage the length of belt that would be wound up and the height the weight would be raised per revolution of the pulley would be *L* ft. × 2 × 3.1416, and this multiplied by the r.p.m. and value of the weight in pounds would be the foot-pounds exerted per minute.

For example, if *L* = 8$\frac{1}{4}$ in., r.p.m. = 300, and the total weight *B* = 11$\frac{1}{2}$ lb., then the work developed would be $\frac{8\frac{1}{4}}{12} \times 2 \times 3.1416 \times 300 \times 11\frac{1}{2} = 14{,}677$ ft.-lb. per min., or 14,677 ÷ 33,000 = 0.44 b.hp.

An International Boiler Code

Boiler-Plant Testing. By David Brownlie, London. Published by Chapman & Hall, Ltd., 1922; E. P. Dutton & Co., New York City. Cloth; 6 x 9 in.; 168 pages; illustrated. Price, 10s. 6d.

Mr. Brownlie's book is an argument and a plea for a standard international up-to-date boiler code devised on thoroughly practical lines. The report of the committee appointed by the Institute of Civil Engineers in 1897 on "Tabulating the Results of Steam Engine and Boiler Fuels," was revised in 1913, but the standard code in Great Britain, is too complicated, unpractical and out of date. The Boiler Code of the American Society of Mechanical Engineers, now under revision and still open for criticism in its tentative form, is, in the author's opinion, much superior to the British Civil Engineers' Code.

The time is ripe for the devising of a Standard International Boiler Testing Code by the American, British and French engineering and scientific societies working in collaboration.

This book, which is a contribution toward such an activity, treats in four distinct parts:

I. The results at present being obtained on boiler plants in general, to show the necessity for and character of the proposed code.

II. Criticisms of existing codes and suggestions for improvement.

III. Suggestions for features that may be added in the future to an International Code as the result of further discussion and investigation.

IV. Design of a new and improved code as a suggested basis for the International Code.

In Part I the author gives 48 pages of results from his own practice and discussion thereon. In the light of 400 tests which he has tabulated, many of which were made to include or were checked by long periods of practical operation, he finds the efficiencies given by such authors as Bryan Donkin, W. S. Hutton, A. B. W. Kennedy and others, "much too high for average working conditions." The true average net working efficiency, including superheaters and economizers, shown by the 400 tests is 58 per cent, that for each of several industries being: Colliery, 55.52; chemicals, 57.90; dyeing, bleaching, finishing, etc., 61.41; paper making, 65.07. Individual plants are working at all kinds of efficiencies from 32 to 82 per cent.

The average amount of water evaporated per pound of coal, reduced to 12,000-B.t.u. coal and 110-deg. feed, is 6.65 lb., or, say, 7.5 lb. from and at 212. Figures like 9 to 10 lb., which are popularly imagined to apply to most boiler plants, apply to only about 5 per cent of the plants of the country.

Of the 250,000,000 tons of coal mined in Great Britain, 36 per cent, or 48 per cent of the home consumption, is used for steam generation. Of this 6,500,000 tons is being burned at, say, 70 per cent efficiency or over, 13,000,000 tons at say, 65 to 70 per cent, 15,500,000 tons at say, 60 to 65 per cent, 21,500,000 tons at 55 to 60 per cent, 18,000,000 tons at 50 to 55 per cent and 15,500,000 tons at less than 50 per cent.

Of the 400 plants tested, 2 are working at 80 per cent or over, 9 at 75 per cent or over, and 17 at 70 per cent or over. It is quite possible, therefore, with ordinary plant and management, to maintain an average yearly efficiency of 75 per cent. Tables are given of the average results in different industries and with different types of boiler.

In his criticism of existing codes he calls the grouping of boiler and engine tests in the "Civils'" Code a persistent relic of the days of over a hundred years ago, when "engine" meant the whole power-producing outfit. "It is for the same reason also that American engineers still persist in talking of 'boiler horsepower,' an unscientific term which died out in Great Britain years ago."

The "Civils'" Code gives the unfortunate impression that boiler-plant testing is a costly and troublesome luxury and that there are two kinds of tests—those made to obtain data for scientific purposes and commercial tests. The author would draw up the code with the idea that boiler-plant testing is to keep boiler plants at maximum efficiency every week all the year round, and make it flexible in the sense that it would include all special tests.

In the matter of duration of test Mr. Brownlie says that the American "Mechanicals'" Code is infinitely more sensible, definite and practical than the "Civils'" Code, which simply says that it should be as long as possible and never less than three hours. The American Code fixes the minimum amount of coal burned per square foot of grate surface.

The author would propose that in the International Code no test should be regarded as official if of less than eight hours' duration, and in every case longer than this or the full working day or shift is much preferable. It would not be possible to include the American figures of ten hours and twenty-four hours in an International Code, because, for example, in Great Britain, the average working day is only eight hours.

A matter for serious consideration is the total omission of all reference to the figures of the performance of the boiler plant when starting and stopping, when banked up and on light load at night and during the week-end. Anything from 10 to 30 per cent of the coal is absorbed in this way, and a test carried out in the spirit of both the Codes applies, therefore, only to the 70 to 90 per cent of the coal burned during the working hours.

In the International Code he would suggest a long check test of a complete week of 168 hours. A combination of the two tests would give, in the author's opinion, a much more satisfactory test of a boiler plant from a practical as well as from an academic and scientific point of view. It is not apparent from the text how elaborate or circumstancial this "check test" is expected to be. Out of 365 plants so tested, 185 gave a slightly inferior result as compared with the day's test and 180 a somewhat better result.

We are pleased to see Mr. Brownlie declare in favor of the higher value in stating the heat content of fuels. The "Civils'" Code decides for the low. Mr. Brownlie is puzzled by the inclusion in the "List of Apparatus required for a Boiler Test" in the British "Civils'" Code of "a Barrus or other calorimeter." Mr. Barrus was chairman of the committee that formulated the American Code which Mr. Brownlie commends so generally, and his calorimeter is an instrument designed to determine the amount of moisture in steam instead of the amount of heat in fuel like the various hyphenated forms of Mahler with which he confuses it. The use of such an instrument, which is quite common with American engineers, would have lessened the practical difficulties which the author finds in the way of determining steam quality, and on account of which no attempt was made to determine how much of the product was water and how much steam in the series of 400 tests upon which the analysis in Part I is based.

The author says that "for some extraordinary reason it has always been the custom for most recognized authorities on boiler-plant testing to disparage the CO_2 recorder," and would in the International Code make it compulsory to use such an instrument, working at a proper speed of about fifteen analyses per hour.

Mr. Brownlie is quite tolerant of meters and believes that very few trials in which the quantity of water is determined by weighed tanks are accurate within one per cent in this respect.

In the International Code he would abandon the determination of the moisture in steam, as the results are dubious and not worth the trouble. He would insert separators or steam driers in the boilers themselves and assume the steam to be dry. The procedure in the case of boilers not so provided is not indicated.

He is quite satisfied with the figures for the specific heat of superheated steam as determined by Knoblauch and Jakob and would make them the official values for the International Code.

In his opinion, "one of the most serious defects in both the American 'Mechanicals'' and the 'Civils'' Code is the scanty attention given to the question of steam or power used auxiliary to the production of steam." The American Code, however, says that it should be determined and recorded in the table of Data and Results.

We can hardly agree with Mr. Brownlie's statement that the American "Mechanicals'" Code recommends the use of

steam meters. The Boiler Code of 1918 does not mention them in the enumeration of Apparatus and Instruments required, but the paragraph on Steam Measuring Apparatus general to all the codes says that they *may* be used if calibrated under the conditions of use and if the pulsations in pressure are not serious. It has been ruled out by the advice of the makers themselves for use in tests of reciprocating steam engines.

Mr. Brownlie says that the only matter for criticism in the American Code is that it does not make the use of steam meters compulsory, but the "Civils' " Code does not allow them at all.

He urges the expression of the performance of a boiler in pounds of water from and at 212 deg. per million B.t.u., which involves the quality of the fuel as well as the temperature of the feed water and the pressure and quality of the steam.

It is a waste of time to record barometer readings as both codes require. Absolute pressure may just as well be taken at gage pressure plus 15 pounds.

In Part III, offering suggestions for features that may be added in the future to an International Code, the author argues for some method of calculating efficiencies not simply upon the basis of the heat in the fuel, but by taking into account in some way the fact that on account of practical difficulties in its handling it is impossible to utilize so large a proportion of the heat in a poor as in a good coal. He suggests the inclusion of the cost of making 1,000 lb. of steam which will show the desirability or non-desirability of using the cheaper grade, although it does not give a basis for comparison between tests on account of disparity in prices of the same fuels.

What is required is that there should be added to the ordinary calculated efficiency a further quantity X which would vary according to the heating value and quality of the fuel.

Another suggestion, which it appears to us would carry the Code beyond the realm of boiler testing, is to include the cost of operation, involving labor, attendance, repairs, upkeep, interest and depreciation, dust and grit in chimney gases, etc.

It is impossible within the limits of a book review to comment upon the suggested International Code. We shall therefore, reproduce it in an early issue for the consideration and comment of our readers, especially those who are interested in the revision of the existing codes and whose practice is affected by their application. We concur most heartily with the contention of the author that a code should be formulated so broad and flexible and universally acceptable that it would become international by general adoption, and the best engineering talent of all nations should be combined in its making.

The Internal-Combustion Turbine

M. Deschamps, in a discussion published in the *Revue Générale de l'Electricité*, Feb. 18, 1922, and reprinted in *The Engineer*, London, challenges the opinion expressed by Professor Schule in his lecture before the German Union of Electro-Technicians (*Power*, May 2, 1922) that the constant-pressure type of gas turbine cannot succeed and that the Holzwarth explosion type alone has a future, and maintains that the outlook for the constant-pressure type is equally favorable.

M. Deschamps contends that in seeking for a solution of the gas-turbine problem it is necessary continually to bear in mind the historical development of the piston engine, since the principles of thermodynamics are invariable and apply equally to both the turbine and the piston engines, so that the study of the development of the one should afford a guide to that of the other. He points out that to increase the efficiency of the early piston engine, the compression was gradually raised until the limit was reached, beyond which it was not possible to go without danger of premature explosion. To increase still further the efficiency by raising the compression it became necessary to inject the fuel at the end of the compression stroke, thus leading to the Diesel type of constant-pressure cycle. The same reasoning holds good for the turbine types and indicates the employment of high compression and combustion at constant pressure.

The constant-pressure turbine has the merit of simplicity and requires no mechanically operated valves exposed to hot gases. The temperature and velocity conditions are very steady throughout the cycle, and there are no sudden fluctuations such as occur in the constant-volume cycle. This is an important consideration. The chief disadvantage of the constant-pressure cycle is that the negative work forms a comparatively large part of the total, and a big compressor is therefore necessary. A piston compressor is out of the question on account of the bulk of the gases to be dealt with, while present-day rotary compressors have a poor efficiency if anything beyond a moderate compression is required. In the mixed-fluid constant-pressure turbine where a combination of steam and gases is used, the ratio of positive to negative work is greater than is the case in the single-fluid type, for the condensation of the exhaust steam eliminates a large percentage of the exhaust gases. In dealing with the question of steam injection for diluting the working substance and lowering its temperature, M. Deschamps criticizes Professor Schule's contention that the lowering of the temperature in the Armengaud-Lemale turbine by steam injection was fatal to its efficiency, and calls attention to a paper by M. Sekutowiez before the *Société des Ingenieurs Civils de France* in 1906, in which it was shown in a striking manner that the injection of steam into a combustion chamber does not have any material effect on the efficiency and permits certain advantages to be secured.

Advantages of the Constant-Volume Turbine

The constant-volume turbine is less dependent upon the compressor, as in this cycle the ratio of positive to negative work is much larger than in the constant-pressure type. The constant-volume type, however, has the disadvantage of being more complicated owing to the mechanically operated valves subjected to high temperatures which are required to close the combustion chamber while the explosions are taking place. The pressure in the combustion chamber is continuously falling during the expansion, so that the velocity with which the gases leave the nozzles and enter the moving blades must be continually diminishing, a state of affairs that is not conducive to efficiency. The gas flow through the turbine wheel is considerably different in the constant-volume turbine from what is the case in either the constant-pressure or steam turbines. For the latter the gas or steam flow is steady, while in the constant-volume turbine the combustion products are ejected from the combustion chambers like machine-gun fire, the pulses of the jets of gas being intermittent, of short duration, and acting like a hammer blow, as the emptying of the chamber and the flow through the wheel does not take more than one-tenth to one-twentieth of a second. The stresses on the blades are, as a consequence, much greater than is the case with steady flow. A further disadvantage is that it is necessary to inject cold air for scavenging and to cool the combustion chamber walls and turbine blades; this air, which has only a small pre-compression, will therefore leave the nozzles and pass through the blades with a much lower velocity than the hot gases, which again is not conducive to efficiency. It becomes questionable as to whether it is better to inject the cold air separately or mix it with the products of combustion.

The Holzwarth turbine does not lend itself readily to a sub-atmospheric cycle such as is possible with the constant-pressure turbine, and therefore suffers a disadvantage in that the frictional losses in the turbine are enhanced and the mechanical efficiency thereby reduced. A good over-all efficiency can be obtained by working on a cycle of comparatively low thermal efficiency with small mechanical losses, or by working on a cycle of higher thermal efficiency with larger mechanical losses. The turbine has a lower mechanical efficiency than the reciprocating engine, and to obtain the same, or greater, over-all efficiency, it is necessary for the turbine to work on a cycle of greater thermal efficiency, and it is only by making use of a better vacuum that the steam turbine has been able to rival the reciprocat-

ing engine. The Diesel engine working on a super-atmospheric cycle owes its high efficiency to the fact that the operations of expansion and compression are both carried out in this type of mechanism with great efficiency, thus giving the engine, as a whole, a high mechanical efficiency. In order to obtain an efficiency approaching that of the Diesel engine, it will be necessary to work an internal-combustion turbine on a sub-atmospheric cycle, and the constant-pressure type alone is suitable for such operation.

Professor Schule gives curves in which he compares the efficiencies of the Holzwarth and constant-pressure turbines with a piston engine working on an Otto cycle. The diagrams given in his paper, in which thermal efficiency is plotted to a base of compression ratio, show that the curves for the constant-pressure turbine and the piston engine lie very close together, while that for the Holzwarth turbine lies distinctly above them, particularly at low compressions. From these curves Professor Schule concludes that the efficiency of the Holzwarth turbine is greater than that of the piston engine and constant-pressure turbine at all values of the compression ratio, and particularly so for low compressions. He omits, however, to mention that the constant-volume turbine can operate only with a low precompression, while the constant-pressure turbine can utilize a much greater compression ratio, and that a fair comparison is not given by comparing the efficiencies obtainable at the same compression ratio.

M. Deschamps remarks that the efficiency of the Holzwarth turbine which functions with a feeble precompression is insufficient, and that the trials have shown all that it is capable of. He hails with satisfaction the statement of Professor Schule that its efficiency is greater than that of a piston engine of the same compression ratio as showing that the more complete expansion and diminished heat losses to the walls surpass the disadvantage of the turbine's lower mechanical efficiency. It is difficult, however, to believe this claim, and in the absence of definite statements as to the fuel consumption per shaft horsepower available for external work, it was considered that such a claim cannot be definitely established, and in any case such an efficiency would not be sufficient to enable the gas turbine to compete with the steam turbine.

Ignition in Gas Engines

By O. E. Turner

Sparks have to be produced at the plug electrodes in the cylinder of a gas or gasoline engine toward the end of the compression stroke. Leaving out of account the question of timing and regarding a magneto or an induction coil simply as a form of high-voltage generator, it is necessary to state as precisely as possible in what way its performance is to be judged and exactly how its output is to be measured. During the war many measurements of spark energy, voltage and current were made, the assumption being that the values thus obtained represented figures of merit for each generator. Later investigations, however, have shown that this is not so. Enormous differences in spark energy, as between widely different types and sizes of generators, have been found to cause no observable differences in the energy developed from the explosion, and the view most generally held at present by those who have studied this subject may be stated as follows: If a spark actually occurs at the plug, ignition will follow, provided that an explosive mixture is present in the cylinder; however much the spark energy be varied, no variation in the power developed will follow. If a spark takes place and no explosion follows, no increase in the energy of the spark will cause an explosion. It is still held by some that the earlier view is correct, and experimental evidence is pointed to of increased spark energy being accompanied by increased engine power. To this the reply is that under certain adverse conditions sparking may not be absolutely regular, and as such missing is, at high speed, difficult to detect, it is not unnatural to ascribe the increased power to increased energy per explosion, when rightly the increase ought instead to be attributed to an increased number of explosions of the same energy.

Assuming, then, that it is necessary merely to cause a spark without any regard as to its character, the requirements to be fulfilled by an ignition generator may be stated thus:

(1) The spark must take place at a cylinder compression varying, according to the type of engine, and the conditions of working, between 30 lb. and 160 lb. per square inch. The voltage required to break down the gap between these limits of pressure depends on several factors, but may be taken roughly as from 5,000 to 25,000 volts.

(2) Sparking must be absolutely regular between whatever limits of low and high speed are required by the engine to be fired.

(3) The functioning of the generator should be as far as possible unaffected by such variations as may occur in the external circuit to which it is connected.

With regard to the first of these requirements the highest pressures are required on large stationary engines; automobile engines do not as a rule operate with pressures much exceeding 100 lb. per sq. in. So far as automobile engines are concerned, it has also to be taken into account that the spark takes place at high speed in a much lower compression than at low speed; one reason for this is that, in order to develop the maximum power, the spark is (at high speed) timed to take place considerably before the end of the compression stroke, and consequently before the maximum compression is reached; another reason is that at high speed there is a certain amount of unavoidable throttling in the induction system, which will result in a lower pressure than at slow speed throughout the whole of the compression stroke. In the table particulars of a number of automobile engines of different characteristics are collected; from this it is seen that the compression at the moment of explosion may be at high speed actually less than half the maximum, or slow-speed, compression.

CYLINDER COMPRESSIONS AT MAXIMUM ENGINE SPEED

		Compression, Lb. per Sq.In.		
Maximum Engine Speed	Maximum Angle of Advance	Maximum Possible	Actual (At Stated) Angle)	Ratio of Actual To Maximum Compression
2,500	45	100	45	0.45
2,800	45	100	58	0.58
3,000	45	100	53	0.53
3,700	50	130	63	0.48

The limits of speed between which the generator must function, the second requirement heretofore referred to, vary according to the type of engine; the upper limit depends on the maximum engine speed and the number of cylinders. It would be better if there were no lower limit, but a magneto must be turned at a certain speed in order to begin sparking.

The third requirement refers to variations in the external circuit. The two factors that affect the sparking most are the presence of capacity in series with the plug electrodes and the joint resistance of the leakage paths in parallel with them. The former is of importance only when very long leads are run to the plugs and are surrounded by metallic sheathing; as a general rule the capacity thus introduced may safely be ignored. Leakage resistance paths, however, are liable seriously to affect the sparking, and they therefore require some consideration. If a resistance of, say, 100,000 ohms were connected in parallel with a plug, it would be found that unless the ignition generator were a particularly robust one, the spark would be quenched, the resultant load on the generator being, through this additional circuit, sufficient to reduce its terminal voltage below the value necessary to break down the gap.

It is, unfortunately, impossible to prevent the formation of a number of these branch circuits; some of them, owing to the presence of moisture, consist of paths of surface leakage across the insulation, both at the generator and at the plug terminals; others are formed through the body of the plug, and their resistances vary according to the temperature of the plug, the amount of carbon which may have been deposited on it, and other factors. All these paths are in parallel with the main circuit. The third requirement—that the generator shall be as far as possible unaffected by variations in the external circuit—may thus be given the following definite form: If R is a resistance in parallel with the spark gap and is gradually reduced to a value R_1 at which the sparking begins to be irregular, then $1/R_1$ is a measure of the ability of the generator to spark under adverse circumstances.—*Engineering.*

News in the Field of Power

Large Attendance Expected at A.S.M.E. Annual Meeting

Sessions on Research, Economics and Engineering Education Will Be Held

PUBLIC HEARINGS of the society's power test code and of the boiler code, the basis for laws in eighteen states, will feature the annual meeting of the American Society of Mechanical Engineers, to be held in the Engineering Societies Building, New York City, Dec. 4-7. At that time John L. Harrington of Kansas City will succeed Dean Dexter S. Kimball of Cornell University as president of the society.

Notable among the reports to be presented is that by the committee on training for the industries, covering recent advances in correspondence work in extension schools, industrial training schools and training in the works. The society maintains student branches in sixty-two colleges and technical schools and there will be a session of the meeting planned and directed by students themselves.

Joint Economic Session

An opportunity for gaining a broader view of the economic side of engineering will be afforded by the joint session with the American Economic Association. H. F. Loree, president of the Delaware & Hudson Railroad Co., and E. M. Herr, president of the Westinghouse Electric & Manufacturing Co., will be among the speakers at this economic forum. Other joint sessions have been arranged with the safety and refrigerating engineers' societies and with the American Engineering Standards Committee.

The sessions of the professional divisions will report progress in a wide range of industrial and technical fields, including developments in aeronautics. Orville H. Wright is a member of the aeronautics division. The ordnance division is working with the army authorities to produce better ordnance and eliminate the evils revealed by the war. At the research session the results of several original investigations will be made known for the first time.

New Committees and Delegates

Elections of executive committees to direct the work of the professional divisions during the coming year have been announced at the national headquarters of the society in this city. The new chairmen are: Aëronautics Division, Major T. H. Bane, U. S. Air Service, Dayton, Ohio; Forest Products Division, Thomas D. Perry, Grand Rapids, Mich.; Fuels Division, Prof. L. P. Breckenridge, Yale University; Gas Power Division, Van H. Manning, director of technical research, American Petroleum Institute; Machine Shop Division, F. O. Hoagland, Worcester, Mass.; Management Division, R. A. Wentworth, Long Island City, N. Y., Materials Handling, H. V. Coss, Philadelphia, Pa.; Ordnance, Waldo H. Marshall, New York City; Power, John H. Lawrence, New York City; Railroad Division, James Partington, New York City, and Textile Division, Charles T. Plunkett, Adams, Mass.

Delegates to the American Engineering Council have been elected by the society as follows: L. P. Alford, New York City; E. R. Fish, St. Louis; Dean Arthur M. Greene, Princeton; John L. Harrington, Kansas City; Edwin B. Katte, New York City; Fred R. Low, New York City; Fred J. Miller, New York City; S. W. Stratton, new president of the Massachusetts Institute of Technology, and Max Toltz, of St. Paul.

The tentative program of the meeting will appear in next week's issue.

Chicagoan New President of Dodge Company

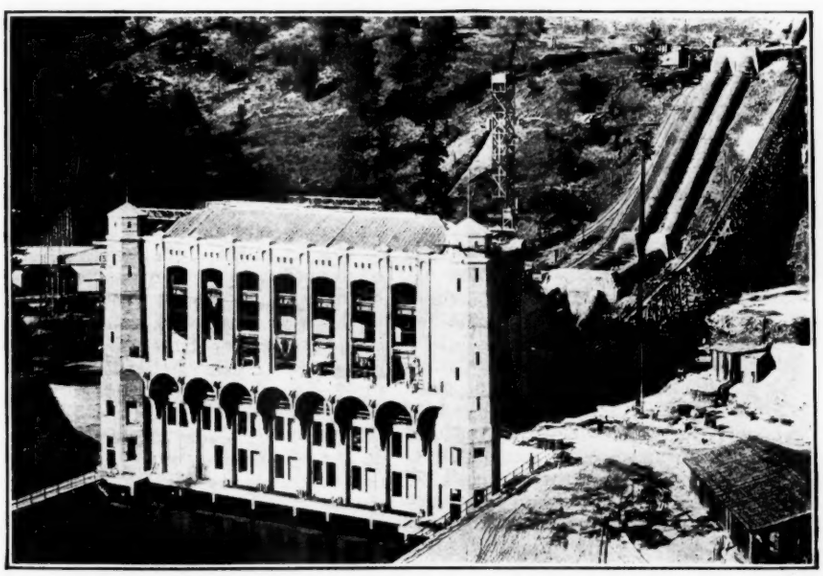
A number of the highest officials of the Dodge Manufacturing Corporation severed their connections with that organization on Oct. 21. President Melville W. Mix was the first to go, selling his interest for $1,500,000. His son, publicity manager, also resigned. W. B. Hosford, vice-president and Harry Bell, foundry superintendent, were pensioned for life. The resignation of Charles Endlich, treasurer, and W. L. Chandler, assistant treasurer, who is president of the Mishawaka Chamber of Commerce, caused considerable surprise.

Charles F. Morse, a well known corporation attorney of Chicago, has been chosen to succeed Mr. Mix as president of the corporation, and Mayor William W. Dodge of Mishawaka, Ind., who holds the controlling interest, is the new vice-president.

Appraisal of Power Property Halted by Questions of Policy

Evaluation of the properties of the Niagara Falls Power Co. by the Federal Power Commission apparently has been suspended. When the work was started, it was understood that it was as much for the purpose of determining how much is involved in the evaluation of such a plant under the proposed accounting regulation of the Commission as it was to determine the actual value of this particular property.

Before the government accountants had proceeded far with their work, a number of points of controversy arose which resulted finally in the power company appealing to the Commission for a hearing in regard to the matter. Although no official expression has been made, it is believed that the Commission will order the suspension of the evaluation work on this plant until a number of points involving matters of policy have been decided upon. It also is possible that the resumption of the work may await the action of Congress in the matter of providing suitable personnel to carry forward this phase of the Commission's duties.



"PIT NO. 1," A SPLENDID EXAMPLE OF POWER PLANT ARCHITECTURE
This plant, operating at 220,000 volts, raises the Pacific Gas & Electric Co.'s installed capacity to 525,000 hp.

Ford Negotiates for Big Strip of Coal Land

According to local newspaper reports, Henry Ford was, on Nov. 1, negotiating with the Wayne Coal Co., of Pittsburgh, for the purchase of more than 30,000 acres of land in eastern Ohio and western Pennsylvania, containing about 180,000,000 tons of bituminous coal. This tract contains practically all the Pittsburgh No. 8 seam, now being worked by the stripping method. Well-informed coal men placed the price in excess of $15,000,000.

Brown Coal Is Not Lignite, Says O. P. Hood

The lignite problem of the United States can not be compared with that of Germany, and no ready-made solution adaptable without change to conditions here may be looked for, according to O. P. Hood, mechanical engineer of the United States Bureau of Mines, who has just returned from a three months' trip to Europe.

"Germany is able to run her industries on a grade of fuel that any American fireman would call impossible," said Mr. Hood. This statement was made with special reference to the Cologne and Halle districts, where brown coal is produced.

"Americans have compared American lignite and German brown coal with the idea that the two are quite similar. As a matter of fact, a distinction is made in the brown coal districts between lignite and brown coal. Brown coal, extensively briqueted and to some extent distilled, is 60 per cent water and is not mined by blasting but dug by shovel machines. It is this difference in the fundamental character of the material that makes it useless to expect a ready-made answer from abroad to America's lignite problem."

Mr. Hood also visited Switzerland, where he found a very interesting fuel-testing laboratory, maintained by the government to protect the interests of the country as an international purchaser of coal. He is preparing a report for Congress on his European investigations.

Chicago N.A.S.E. Commemorates Fortieth Anniversary

To commemorate the fortieth anniversary of the national body and to honor James G. Beckerleg, past national president and one of the founders of the organization, the combined N.A.S.E. associations of Chicago held a dinner meeting on Oct. 25 at the City Club. An attendance of about four hundred entered enthusiastically into the spirit of the occasion. Special music and community singing of old-time songs opened up the channels of good fellowship and swayed the audience into a mood receptive to the inspirational talks on the program.

Acting as toastmaster, Joseph O'Connell referred briefly to the wisdom displayed forty years ago by the twelve men who met in New York City to inaugurate the association. That they had built better than they knew was indicated by a roster of 23,000, an excellent paper and many other good things that had accrued from that meeting. Henry R. Rathbone, representing the Chicago Association of Commerce, spoke on the two cardinal principles of the organization—education and co-operation. John W. Lane referred to the association as a bell-wether to thousands of engineers, and Past President Parry pointed out that much of the progress made in mechanical lines originated from improvements instigated by operating engineers. As the closing event Charles W. Naylor in his inimitable way presented to "Dad" Beckerleg a camel's hair vest of the finest quality as a token of the esteem and honor in which he is held by the engineering fraternity.

Coming Conventions

Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 4-8.

American Society of Refrigerating Engineers; W. H. Ross, secretary, 154 Nassau St., New York City. Annual meeting at New York City, Dec. 4-6.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 7-13.

Reports Greater Sale of Ships with Old-time Equipment

While Shipping Board vessels equipped with Scotch boilers and reciprocating engines have found more ready sale than those with water-tube boilers or geared turbines, engineers of the Board believe that this is due more to individual prejudice than to any lack of reliability on the part of the more modern equipment.

Since a great variety of motive equipment was used in the vast merchant fleet built for the government during the war, the Shipping Board now has a collection of comparative performance records which is probably of greater value than that of any private organization. However, the condition of shipping since the war has not led the Board to experiment, and only recently has any effort been made to check carefully on performance. While this check is still incomplete, the existing records have permitted certain unofficial deductions, as follows:

There was more general complaint of lack of efficiency from engineers operating water-tube boilers than from those in charge of Scotch boilers. Whether this was justified by actual failure of equipment or whether it may be charged to greater familiarity with the Scotch type remains to be determined by an accurate check. Opinion in Shipping Board circles has it that prejudice of the operating personnel should bear the greater responsibility.

The same explanation is given for the greater number of complaints against geared turbines than against reciprocating engines. In certain cases trouble was had with gears which were imperfectly adjusted, but with proper installation and sufficient knowledge of operation it was found that turbine performance was fully equal to that of reciprocating engines.

Personnel Men To Discuss the Human Factor

Industrialists, educators and personnel experts will take part in the first annual convention of the National Personnel Association, to be held at Pittsburgh, Nov. 8-10.

The numerous addresses, discussions and committee reports, covering a wide range of administrative effort, will center around the problem of "the human factor in industry," now of outstanding importance in this and other countries. Immigration, psychological tests, motion pictures, pension plans for workers, employment and labor turnover, shop training and the relation of industry to both the engineering and the public schools will be discussed as questions pressing for solution.

Michael Pupin, professor of electro-mechanics at Columbia University and famous for his contributions to radio, will deliver an address on "The Immigrant's Point of View." Professor Pupin, born in Serbia, began life as a shepherd boy, coming to America with a nickel and an apple as his sole possessions.

"Industry and the Engineering Schools" will be the subject of addresses by F. L. Bishop, dean of the University of Pittsburgh, and W. D. Wickenden, assistant vice-president of the American Telephone and Telegraph Co. Speakers at a session on "Industrial and Public School Relations" will include C. S. Coler, manager of the Westinghouse educational department; R. L. Cooley, superintendent of Continuation Schools, Milwaukee, and Dr. Clifford B. Connelley, Commissioner of Labor, Pennsylvania.

Spreads the Federation Idea Throughout the West

Completing his coast-to-coast tour, during which he set in motion plans for the expansion of the Federated American Engineering Societies, L. W. Wallace, executive secretary of the Federation, has returned to New York City. Citing the work of the committees on the "Elimination of Waste in Industry" and on "Work Periods in Continuous Industry" as evidence of the influence exerted by the Federation since its organization about two years ago, Mr. Wallace spoke before large engineering gatherings in many cities. Everywhere, he reports, engineers are recognizing the potential power of the Federation for technical and public service.

Mr. Wallace began his tour from New York City, speaking first to the engineering students of the University of Nebraska at Lincoln on Sept. 18. He next addressed a joint meeting of constituent societies under the auspices of the Colorado Society of Engineers at Denver, Sept. 20. He also spoke before

the faculty and students of the Colorado School of Mines at Golden.

At San Francisco, his principal stop, he addressed the meetings of the American Society of Civil Engineers and the American Institute of Mining and Metallurgical Engineers, urging before the latter body revision of the mining laws. The first stage of his journey included addresses before the Joint Technical Societies of Los Angeles and the engineering students of the University of California.

Returning, Mr. Wallace spoke at the following places: State College, Pullman, Wash.; University of Idaho, Moscow; Oregon Agricultural College, Corvallis; Oregon Technical Council, Portland; Associated Engineers, Spokane; State School of Mines and Montana Society of Engineers, Butte; Duluth Engineers Club, and Engineers Club of Northern Minnesota, Duluth.

The final events of the trip were two meetings in Columbus, Ohio, on Oct. 20, when Mr. Wallace addressed a luncheon meeting of the Chamber of Commerce and later the industrial engineering students of Ohio State University on "Waste in Industry."

Power Merger in the Northwest

Through a stock merger the Washington Water Power Co. will, on Jan. 1, 1923, take over the Okanogan Valley Power Co., operating two hydro-electric plants which supply light and power to towns and farming districts of the Okanogan Valley. The Washington company will extend its lines into the new field, connecting with the south end of the Okanogan territory at Pateros on the Columbia River. From 55 to 70 miles of 60,000-volt transmission line, it is estimated, will be required to complete the connection.

Water-Power Projects

The first water power application affecting the international boundary between the United States and Mexico to come before the Federal Power Commission is that of **R. W. Morrison**, of St. Louis, who would erect a power dam 30 ft. high in the Rio Grande, ten miles above Laredo, Tex. No public lands are involved, but Congress has declared on various occasions that the Rio Grande is to be regarded as navigable as far up as El Paso. Permission has been obtained from the Mexican government for the construction of that part of the project located in Mexican territory.

Obituary

William Blake Wood, president of Gifford-Wood Co., Hudson, N. Y., died Oct. 28 at the Albany City Hospital, after a two weeks' illness. Mr. Wood was born in Arlington, Mass., in 1869. He became a member of the firm of William T. Wood & Co., of Arlington, upon the death of his father Cyrus in 1896 and continued as a partner of William E. Wood and later as a member of Gifford-Wood Co., incorporated in 1905. He moved with his family to Hudson in 1911 and succeeded Malcolm Gifford as president upon the latter's death in 1919. Mr. Wood leaves a wife, Mabel Adams Wood, and children, Philip, Rosamond, Winthrop, Elizabeth, Katherine and Cyrus.

G. C. G. Gray, consulting engineer for the Automatic Fuel Saving Co. from 1919 to 1921 and the inventor of several systems of automatic combustion control, died on Oct. 9 after a long illness. Mr. Gray was born in 1868 in Glasgow, Scotland, and was a graduate of the University of Glasgow. While still a youth he came to this country and was put in charge of the erection of six engines of Scotch manufacture. From that time on he remained in this country, always being affiliated with engineering work. He served a number of years as chief engineer of Bryn Mawr College and also performed consulting work.

Society Affairs

Detroit-Ann Arbor Section, A.I.E.E., will hear a talk by A. C. Marshall, vice-president of the Detroit Edison Co., at its meeting on Nov. 10 at the Connors Creek Power House.

Boston Society of Civil Engineers will meet on Nov. 8 at 6 p.m. in the Affiliation Rooms to hear an address, "Handling Materials by Conveying Machinery," by Nixon W. Elmer, consulting engineer.

Chicago Section, A.S.M.E., will meet on Nov. 14 at the Engineers Club. Harry Sloan, president of the A.S.R.E., will speak on "Autogenous Welding as Applied to Unfired Pressure Vessels."

Metropolitan Section, A.S.M.E., will meet on Nov. 14 at the Engineering Societies Bldg. to hear an address by Carl Jefferson on "U. S. Shipping Board Tests of Scotch Marine Boilers."

Plainfield Section, A.S.M.E., will enjoy a dinner at 7 p.m. on Nov. 15 at the Park Hotel, followed by a meeting at 8 p.m., at which S. W. O'Neil, chief engineer of the Ingersoll-Rand Co., will speak on "A New Development in Internal-Combustion Engines."

Detroit Section, A.S.M.E., is to offer a trophy for the best papers on engineering subjects of civic concern. The prize will be open to any member of the twelve allied technical societies of the city and will be awarded to the first engineer winning the decision three times.

Trade Catalogs

Diesel Engines—Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo. An illustrated bulletin showing a number of installations of Busch-Sulzer engines, and containing information on operation, reliability, wear of parts, and features of Diesel engine economy in general.

Practical Books—Norman W. Henley Publishing Co., 2 West 45th St., New York City. A catalog of the Henley "Practical Books for Practical Men," on air brakes, automobiles, coal, compressed air, electricity, gas and gasoline engines, hydraulics, locomotive engineering, marine engineering, refrigeration, steam engineering, etc.

Tube Cleaners—Liberty Manufacturing Co., Frick Building, Pittsburgh, Pa. Catalog Z-1, describing and attractively illustrating Liberty cleaners for boiler tubes. Disassembled views are given, showing construction and giving names of all parts.

Coxe Stokers—Combustion Engineering Corp., 43 Broad St., New York City. Bulletin CB1, describing the Coxe traveling-grate stokers and giving test results and curves for a number of installations using western and mid-western bituminous coal.

"Drafts and Draft Regulation"—Jos. W. Hays Corp., Michigan City, Ind. A 16-page pamphlet, revised and presented in a more attractive style. In addition to containing a fund of practical information about draft control, the bulletin describes various types of Hays draft gages.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 23, 1922	Oct. 30, 1922
Pool 1,	New York	$4.75–5.25	$4.50–5.25
Smokeless,	Columbus	6.00–6.50	6.00–6.50
Clearfield,	Boston	3.50–4.00	3.00–4.00
Somerset,	Boston	3.50–4.40	3.50–4.00
Kanawha,	Columbus	4.25–4.75	4.50–5.00
Hocking,	Columbus	3.25–3.75	3.50–3.75
Pittsburgh No. 8	Cleveland	3.56	3.56
Franklin, Ill.,	Chicago	4.25–4.75	4.00–4.25
Central, Ill.,	Chicago	3.25–4.00	3.00–3.25
Ind. 4th Vein,	Chicago	4.25–4.50	3.75–4.00
West Ky.,	Louisville	2.25–2.65	2.65–3.00
Big Seam,	Birmingham	2.50–2.75	2.50–2.75
S. E. Ky.,	Louisville	3.25–4.50	3.75–4.25

FUEL OIL

New York—Nov. 2, Port Arthur light oil, 22@25 deg. Baumé, 4⅛c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago — Oct. 27, for 24@26 deg. Baumé, $1.20 per bbl.; 32@36 deg., 3½c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Sept. 12, f.o.b. refinery, Pennsylvania, 36@40 deg., 6¼c.; Kentucky fuel oil, 26@30 deg., 4½c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg., 3¼c.; Western, 24@30 deg., $1.30 per bbl.

Philadelphia — Oct. 30 26@28 deg. Baumé, Oklahoma, $1.05@$1.07½ per bbl.; 30@34 deg., Oklahoma (group 3). 2¾@3¼c. per gal.; 16@20 deg. Seaboard, $1.35@$1.50 per bbl.

St. Louis—Oct. 17, f.o.b. Oklahoma 24@26 deg. $1.15 per bbl.; 26@28 deg. $1.15 per bbl.; 28@30 deg., $1.25 per bbl.; Gas oil 32@36 deg. 3¼c. per gal.; 38@40 deg. distillate, 4c. per gal.

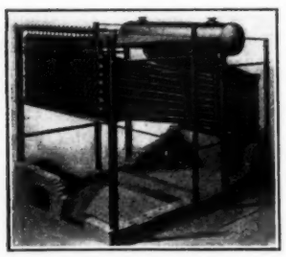
Cincinnati—Oct. 10 for 26@28 deg., Baumé, 5¼c. per gal.; 28@30, Diesel, 5¼c.; 38@40 deg., dstillate, 6c. per gal.

Cleveland—Oct. 10, for 26@28 deg., Baumé, 4½c. per gal.

Condensed-Clipping Index of Equipment

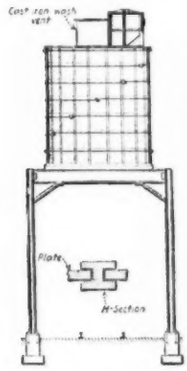
Condensed from previous descriptions in "Power" for convenient filing

Boiler, Cross-drum "Power," 1922.
Page Boiler Co., 815-19 Larrabee St., Chicago, Ill.



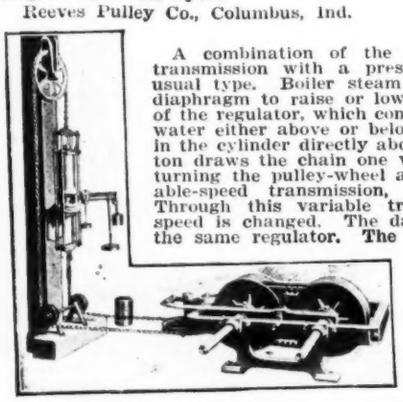
A cross-drum water-tube boiler made in sections so that it may be shipped, knocked down and set up, with a varying number of sections in any reasonable capacity from 1,500 sq.ft. up. Two rows of curved tubes connect the drum with the top of each rear header, the latter being curved back somewhat to allow the tubes to enter it at right angles. The drum is supported separately by structural steel instead of by the rear headers. The sections are made either 15 or 18 tubes high, with a pitch of 3½ in. to the foot. The tubes are 3 in. in diameter. The headers are of cast steel, and are of serpentine shape. There are two rows of liberating tubes from the front header to the drum, permitting the steam to enter the latter at the water line. Described further in "Power" for July 4, 1922, page 16.

Tank, Coal and Ash Storage "Power," 1922.
Conveyors Corp. of America, 326 West Madison St., Chicago



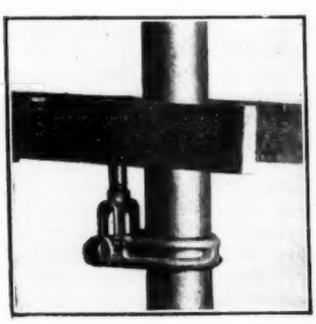
A cylindrical cast-iron storage tank that is made up in sections, ½ in. thick and 2 ft. square. The vertical edges of these sections, or radius plates, are joined, as shown in the illustration, by pieces with an H-shaped cross-section, made in 2-ft. and 4-ft. lengths. Their sections are held together by steel rods running around the tank, and inside joints are sealed with a special cement to prevent leakage. The tank is shown equipped with a standard wash vent and target box used with a steam-jet ash conveyor. Sixteen standard sizes are supplied, the clearances varying from 10 to 22 ft., and sizes ranging from 8 ft. diameter and 12 ft. height, to 16 ft. diameter and 22 ft. height. The capacities of these different-sized tanks, figured on a basis of 40 cu.ft. per ton, range from 15 to 110.5 tons. The weights range from 10,840 to 41,920 lb. Described further in "Power" for May 9, 1922, page 729.

Regulator, Stoker Speed "Power," 1922.
Reeves Pulley Co., Columbus, Ind.



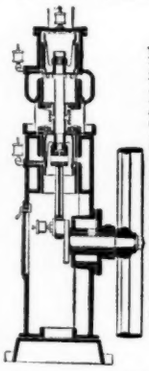
A combination of the Reeves variable-speed transmission with a pressure regulator of the usual type. Boiler steam pressure acts upon a diaphragm to raise or lower the horizontal lever of the regulator, which controls a valve admitting water either above or below the hydraulic piston in the cylinder directly above the lever. The piston draws the chain one way or the other, thus turning the pulley-wheel and adjusting the variable-speed transmission, shown at the right. Through this variable transmission the stoker speed is changed. The damper is controlled by the same regulator. The transmission is driven at a constant speed and may be placed on the floor, the ceiling, or on a special platform. Described further in "Power" for July 25, 1922, page 133.

Hanger, Pipe "Power," 1922.
Heide & Resek, 46 West 43d St., Bayonne, N. J.



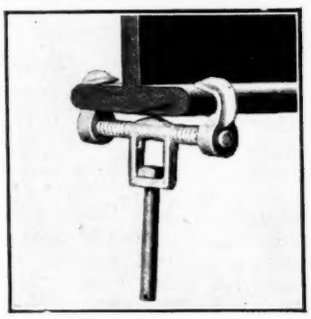
A pipe hanger made particularly to be easily and quickly installed and removed. It is made in several models and may be applied in many different positions. Its holding power comes from a jaw that swivels loosely upon the bolt shown in the illustration. This jaw has a sharp edge that is curved to fit the pipe; when installed, this edge rests against the pipe somewhat above the center of the bolt, and when the pipe starts to slide down, the sharp edge bites into it and holds it securely. Expansion and contraction of the pipe are provided for by the loop in the carrying arm. Described further in "Power" for June 27, 1922, page 1017.

Pump, Priming "Power," 1922.
Barrett, Haentzens & Co., Hazleton, Pa.



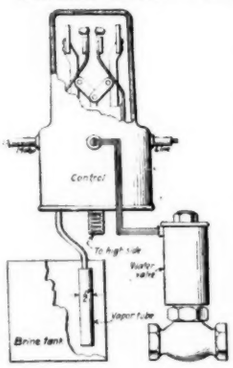
A vacuum pump used for priming centrifugal pumps, consisting of a double-acting piston air pump protected by a float-operated stop valve and vacuum breaker. Only the air pump is shown here. There are no inlet valves, the air being drawn in through ports in the cylinder walls. The discharge valves, which are faced with leather, slide on the piston rod between the two cylinders. The device primes the centrifugal pump by exhausting the air in the pump casing until it fills with water so that it may be started up. Water is prevented from coming over into the air pump by a float-operated trap, which also breaks the vacuum. One priming set may be connected so as to serve any convenient number of centrifugal units, and may also be used to withdraw air from the suction pipe connection of a centrifugal pump during operation in case of aerated water. Described further in "Power" for June 27, 1922, page 1020.

Clamp, Beam "Power." 1922.
Heide & Resek, 46 West 43d St., Bayonne, N. J.



A beam clamp for holding pipes, rods, etc., designed to be quickly and easily applied to any size of beam and as readily removed. The holes in the jaws are oval, with the longer axis vertical. In line with the horizontal axis of the holes teeth are cut that engage with teeth on the connecting rod. When this rod is turned with the bolt parallel with the pipe, the teeth slide through the oval holes, and the jaws may be brought up against the beam. When the rod is turned to the position shown in the illustration, its teeth engage with those in the jaws, and the latter are held tight as long as the rod remains in this position. The clamp is made in three models, light, medium and heavy, according to the service required. Described further in "Power" for June 27, 1922, page 1017.

Refrigeration Control, Automatic "Power," 1922.
Coleman Electric Manufacturing Co., Rising Sun, Ind.



An automatic control for small refrigerating machines, designed to maintain a constant storage temperature, and consisting of a toggle electric switch, magnetically-operated condensing-water valve, protector for the discharge lines, and a refrigerator thermostat. When the refrigerator reaches the predetermined high temperature, the thermostat closes the circuit of the switch. The switch in closing starts the motor and also opens the water valve supplying water to the condenser. When the refrigerator reaches the predetermined low temperature, the thermostat makes the opening circuit of the switch and the operations are reversed. If excessive pressures are developed in the high side of the machine, due to water failure or any other cause, the high-pressure device opens the switch and stops the machine. Described further in "Power" for June 20, 1922, page 976.

Thermometer, Resistance, Direct-Reading "Power," 1922.
Brown Instrument Co., Philadelphia, Pa.

An electrical resistance thermometer that gives a reading in degrees of temperature directly, without the necessity of first adjusting a resistance to bring a pointer to zero. The battery voltage, however, has to be tested every day or so, and adjusted by a rheostat; convenient means of doing this are included in the equipment. Two instruments may be connected in series and may be some distance apart, 100 ft. or more; one may be an indicator and the other a recorder. Described further in "Power" for July 18, 1922, page 85.

For a permanent file of new and improved power-plant equipment, clip and paste on 3 x 5-in. cards. (Patented Aug. 20, 1918.)

New Plant Construction

PROPOSED WORK

Calif., Tracy—The city plans an election to vote bonds for improvements, including $3,820 for pump and motor for wells, consisting of one No. 3-8 stage 14 in. deep well turbine driven pump, driven by 60 hp. vertical 2,200 volt, 3 phase, 60 cycle, induction motor, 750 gal. per min. against 200 ft. head with 36 in. suction and automatic. W. D. Harrington, City Engr.

Colo., Denver—The Denver School Dist., voted bonds Oct. 10 as follows: elementary schools $2,000,000; Senior High $2,400,000; Junior High $1,750,000. Estimated additional cost for equipment $2,400,000. Architect not selected.

Colo., Limon—The city, Office of City Clk., will receive bids until Nov. 15 for new equipment for power house, consisting of Diesel type of oil engine and electric generator. Estimated cost $25,000. Brew & Sydow, 210 Kittridge Bldg., Denver, Engrs.

Conn., Hartford—The Phoenix National Bank, Main St. and City Hall Square, plans to build a bank and office building. Estimated cost $500,000. Architect not announced.

Ga., Atlanta—The Bd. Educ., c/o J. N. Landers, City Purch. Agt., City Hall, will receive bids until Nov. 10, for a 3 story, 385 x 468 ft. colored Junior high school on West Hunter and "C" Sts. E. C. Wachendonff, 620 Forsyth Bldg., Archt. A. T. E. Brown, Forsyth Bldg., Engr. Separate bids will be received for heating and ventilating systems.

Ill., Chicago—W. W. Ahlschlager, Archt., 65 East Huron St., is preparing plans for an 8 story, 200 x 216 ft. hotel including steam heating system, on Washington Blvd. and Homan Ave. Estimated cost $2,000,000. Owner's name withheld.

Ill., Chicago—St. Joseph's Convent, 575 Layton Blvd., Milwaukee, Wis., is having plans prepared for a 4 story, 220 x 236 ft. high school on Byron St. and Lawndale Ave., here. Estimated cost $600,000. Brust & Philipp, 405 Bway., Milwaukee, Wis., Archts. Equipment detail not reported.

Ill., Chicago—Woltersdorph & Bernhardt, Archts., 138 North La Salle St., are having plans prepared for a 12 story, 118 x 125 ft. hotel including steam heating system, on Madison and Hamilton Sts. Estimated cost $1,000,000. Owner's name withheld. Noted Oct. 3.

Ill., Lake Forrest—M. H. Patterson, Deer Path Inn, is having plans prepared for a 4 story, 172 x 233 ft. hotel, including steam heating system. Estimated cost $500,000. Ayres Beck & Co., 118 North La Salle St., Chicago, Archts.

Ill., Vandalia—The city is having preliminary survey made for a water works and distribution system, consisting of a 500,000 gal. filter plant, intake from river, 600 ft. long, chemical treatment plant (alum and lime), about one mile of 4 in. pipe, 400 ⅝ meter, twelve 6 in. valves and six fire hydrants, standard type with 4 in. connections. Estimated cost $30,000. A. H. Beard, 616 Title Guaranty Bldg., St. Louis, Engr. The owner is in the market for two low service motor driven 400 g.p.m. pumps.

Ind., Terre Haute—The Wabash Valley Elec. Co. plans the construction of a hydro-electric power house, including transmission system, on the Wabash River, Sugar Creek Twp. Estimated cost $3,000,000.

Ind., South Bend—The St. Joseph Catholic Church plans to build a 2 story high school. Estimated cost $500,000. Architect not selected.

Ia., Muscatine—The city is having plans prepared for the construction of a municipal electric light plant, distribution system and electrification of the water pumping plant. Estimated cost $350,000. A. L. Mullergren, 555 Gates Bldg., Kansas City, Mo., Consult. Engr. Noted Feb. 22.

Ia., Orange City—The city plans the construction of a light and power plant. Henningson Engr. Co., Nat'l. Bldg., Omaha, Nebr., Engrs.

Kan., Hutchinson—The Walcott Hotel Co., is having plans prepared for an 8 story, 75 x 150 ft. hotel on Sherman and Main Sts. Estimated cost $400,000. McKechnic & Trask, 719 Floyd Bldg., Kansas City, Mo., Archts. Equipment detail not reported.

Kan., Kansas City—The City Water Comm. will receive bids until Nov. 7 for a centrifugal pump, 5,000,000 gal. capacity. R. L. McAlpin, City Hall Bldg., Kansas City, Mo., Engr.

Kan., Leavenworth—The Bd. Educ., will soon receive bids for the construction of a 1 story, 118 x 160 ft. high school on 3rd Ave., including a power house. Estimated cost $150,000. C. A. Smith, Finance Bldg., Kansas City, Mo., Archt. Noted May 16.

Kan., Pittsburg—The Kansas City Southern R.R., 11th and Wyandotte Sts., Kansas City, Mo., is having preliminary plans prepared for the construction of locomotive and car shops, engine shop, power house, etc., here. Estimated cost $1,000,000. W. G. Morgan, Div. Engr.

Ky., Montago—The Means-Haskins Coal Co. is in the market for coal tipple machinery, including handling and conveying equipment.

La., New Orleans — The Sewerage & Water Bd., 526 Carondelet St., received bids for a 6,000 kw. steam turbine and accessories, from the Allis Chalmers Mfg. Co., West Allis, Wis., $162,455, General Electric Co., River Rd., Schenectady, N. Y., $140,837. Noted Aug. 22.

La., Shreveport—J. R. Slattery Co. plans the construction of a 16 story office building. Estimated cost $1,500,000.

Mass., Beverly—The School Comm. is receiving bids for a 3 story, 100 x 150 ft. high school, including steam heating system. Estimated cost $700,000. Adden & Parker, 177 State St., Boston, Archts. Noted June 13.

Mich., Benton Harbor—Wm. Bastar, 719 Lake Blvd., St. Joseph, is having preliminary sketches prepared for the construction of a 7 story, 100 x 100 ft. hotel on Main St. Estimated cost $300,000. Nichol, Scholar & Hoffman, Lafayette, Ind., Archts.

Mass., Gardner—The Gardner Hotel Co., c/o H. L. Stevens & Co., Archts. and Engrs., 522 5th Ave., New York, is having plans prepared for a 5 story, 85 x 100 ft. hotel on Pleasant St. Estimated cost $250,000. Equipment detail not reported.

Mich., Detroit—The Bd. of Commerce, H. E. Coffin, Dir., Wayne St. and Lafayette Ave., plans to build a 20 story, 100 x 120 ft. office building, including steam heating system, on Lafayette Ave. Architect not selected.

Mich., Detroit—The Hotel Tuller Co., Park and Adams Ave., plans to build a 14 story, 60 x 130 ft. hotel addition, second unit, on Bagley Ave. W. H. Adams, 431 Griswold St., Engr. Equipment detail not reported.

Minn., Rochester—Olmsted County, A. L. Glabe, Aud., plans the construction of a 3 or 4 story court house, including steam heating system, etc. Estimated cost $500,000. Architect not selected.

Miss., Corinth—The city council will receive bids until Nov. 28 for waterworks improvements, including 1,000,000 gal. filter plant, 210,000 gal. settling basin, pumping equipment and distribution system, one deep well pump, two 250 g.p.m. motor driven pumps, two 400 g.p.m. motor driven centrifugal pumps, one 250 g.p.m. wash pump, two 400 g.p.m. low pressure service pumps, one 600 g.p.m. spray pond equipment and 25,212 ft. 4 to 6 in. c.i. pipe. Estimated cost $35,000. A. H. Beard, 616 Title Guaranty Bldg., St. Louis, Mo., Engr.

Miss., Louise—The Mayor and Bd. Aldermen, Bay St., will receive bids until Nov. 29, for two 750 gal. water motor driven centrifugal fire pumps, 75,000 gal. tank and tower, 125,000 gal. reservoir, 600 ton 4, 6 and 8 in. c.i. pipe. Estimated cost $90,000. Swanson-McGraw, United Fruit Bldg., Consult. Engrs.

Mo., Columbia—The Stephens College has purchased site adjoining college and plans to build four dormitories and a library building. Estimated cost $850,000. Architect not selected.

Mo., Kansas City—The Bd. Educ. is having preliminary plans prepared for high schools, on 63rd St., 48th St., 74th St. and Penn Ave., a central high school and Willard High school, estimated cost $1,500,000, $1,400,000, $250,000, $500,000 and $250,000, respectively, also Shiloh Grade school, estimated cost $250,000. C. A. Smith, Finance Bldg., Archt.

Mo., Kansas City—The Bd. Educ. will soon award the contract for the construction of a 1 and 2 story, 230 x 250 ft. school on 27th St. and Topping Ave. Estimated cost $2,500,000. C. Smith, Finance Bldg., Archt. Equipment detail not reported.

Mo., St. Charles—The city, O. Boekemeier, Clk., is having plans prepared for the construction of a new water pumping plant. A. L. Mullergren, 555 Gates Bldg., Kansas City, Consult. Engr. Noted Oct. 10.

Mo., St. Joseph—The Methodist Hospital Assn., is receiving bids for the construction of a 7 story, 120 x 180 ft. hospital on 8th and Farson Sts. Estimated cost $750,000. W. Boschen, Tootle-Lacy Bldg., Archt. W. E. Gillham, 309 Mutual Bldg., Kansas City, Consult. Engr. Equipment detail not reported.

Neb., Omaha — The Bd. Educ., W. T. Bourke, Secy., 603 City Hall, received low bid on steam heating and ventilating system and theromostat control, for the proposed 3 story, 174 x 369 ft. North High school on 31st St. and Ames Ave., from J. J. Hanighen Co., 617 South 14th St., $129,643. Noted Feb. 21.

N. J., Newark—The city, C. P. Gillen, Dir., City Hall, is having plans prepared for the construction of a 3 story addition to hospital on Fairmont Ave. Estimated cost $300,000. J. P. Piggot, 665 Broad St., Archt. D. Sprague, 167 West 13th St., New York, Engr. Equipment detail not reported.

N. Y., Alden—Erie County Supervisors, City Hall, Buffalo, are having preliminary sketches prepared for the construction of a county home consisting of a group of buildings, including infirmary, etc., here. Estimated cost $1,500,000. Kidd & Kidd, 234 Delaware Ave., Buffalo, Archts.

N. Y., Alfred—The Alfred University plans the construction of additional buildings, including gymnasium and athletic field. Estimated cost $1,000,000. Architect not announced.

N. Y., Binghamton — The Binghamton Light, Heat & Power Co., 172 Washington St., plans the construction of a 2 story addition to its power house. Estimated cost $70,000. Noted Aug. 15.

N. Y., Brooklyn—A. Levy, c/o Shampan & Shampan, Archts., 50 Court St., is having plans prepared for the construction of a 6 story, 130 x 160 ft. apartment building on St. Johns Pl. and Underhill Ave. Estimated cost $600,000. Equipment detail not reported.

N. Y., Buffalo—The Angola Tire & Rubber Co., 270 North Division St., is in the market for boiler house equipment for proposed boiler house.

N. Y., Buffalo—The Bd. Educ., 1401 Telephone Bldg., will receive bids until Nov. 8 for the construction of a 3 story, 180 x 250 ft. school building on Newburgh Ave. Estimated cost $500,000. Associated Buffalo Archts., 232 Delaware Ave., Buffalo, N. Y. Equipment detail not reported.

N. Y., Buffalo—J. T. Ferguson, 368 Massachusetts Ave., is in the market for a 25 to 30 hp. boiler with 50 to 75 lb. pressure.

N. Y., Jamestown—The Bd. Educ. will receive bids until Jan. 10, 1923, for a 3 story, 150 x 180 ft. Junior high school including boiler room, heating plant, fan and motor ventilating system, on Buffalo St. Estimated cost $350,000. Guilbert & Betelle, 541 Broad St., Newark, N. J., Archts.

N. Y., Mineola—The Nassau Hospital, will soon receive bids for the construction of a 5 story addition to hospital. Estimated cost $350,000. Lord & Hewlett, 2 West 45th St., New York, Archts. and Engrs. Equipment detail not reported.

N. Y., New York—Klar Bros., c/o Gronenberg & Leuchtag, Archts. and Engrs., 450 4th Ave., is having plans prepared for the construction of a 9 story, 65 x 100 ft. office building at 156 West 34th St. Equipment detail not reported.

N. Y., New York—A. G. Schoonmaker & Sons, 25 Church St., are in the market for air compressor, 2 cylinder type, 140 to 160 cu. ft., for machine shop.

N. Y., New York—Warren & Wetmore, Archts., 16 East 47th St., are receiving bids until Nov. 6 for the construction of a 7 story hospital building for the East End Hospital, 87th St. and East End Ave. Estimated cost 1,000,000. Equipment detail not reported.

N. Y., Norwich—The Norwich Gas & Electric Co. plans the construction of an electric transmission line, 44,000 volt, high power. Work will possibly include the construction of a transformer station outside the city. Cost will exceed $25,000.

N. Y., Westover, (Binghamton P. O.)—H. F. Bond, West Lawn Farm, is in the market for a 15 to 20 hp. upright steam boiler.

Ohio, Cleveland—The Bd. Educ., F. G. Hogen, Dir., will receive bids until Nov. 20, for a 2 story, 160 x 300 ft. school on East 140th St. and Diana Ave., estimated cost $500,000; also plans the construction of 3 story Senior High School Annex on Randall Rd. and Bridge Ave., 2 story elementary school on East 144th St. and Castalia Ave., 2 story elementary school on Cranwood Site, estimated cost $2,000,000, $600,000 and $600,000 respectively. W. R. McCornack, East 6th St. and Rockwell Ave., Archt. Steam heating systems will be installed.

Ohio, Cleveland—The Bd. Educ., F. G. Hogen, Clk., plans the construction of 3 story, 25 room High School on Oak Park and Henninger Aves., 2 story, 22 room elementary school on Parkhurst Florian site and a 2 story, 12 room addition to Hicks School Annex, including steam heating systems. Estimated cost $750,000, $500,000 and $200,000 respectively. W. R. McCornack, East 6th St. and Rockwell Ave., Archt.

Ohio, Cleveland—The city will receive bids until Nov 9, for furnishing and erecting 1,200 ton structural steel for the Fairmount pumping station. A. V. Ruggles, City Hall, Engr. Noted Aug. 8.

Ohio, Cleveland—M. Marmorstein, 607 Ulmer Bldg., is having preliminary plans prepared for a 12 story, 150 x 172 ft. stores and apartment building, including steam heating system, on Ford Drive and Euclid Ave. Estimated cost $2,000,000. S. H. White, 1032 Schofield Bldg., Archt. W. S. Ferguson Co., 1900 Euclid Ave., Engrs.

Ohio, Cleveland—The National Provision Co., W. G. Fletcher, Pres., West 65th St., is having preliminary plans prepared for the construction of a 3 story packing house. Estimated cost $300,000. Anders & Reimers, 314 Erie Bldg., Archts.

Ohio, Cleveland—The Y.M.C.A., c/o R. E. Lewis, Secy., East 22rd St. and Prospect Ave., plans to build an addition to its dormitory. Estimated cost $500,000. Architect not selected.

Ohio, Delaware—The Dept. Pub. Welfare, W. H. Duffy, Dir., Oak and Ninth Sts., Columbus, plans the construction of a 60 x 80 ft. power house, 30 x 90 ft. laundry building and water plant, including a 15,000 gal. coagulating reservoir, 26,000 gal. reserve reservoir for waterworks, small pumping station, etc., for the Girls' Industrial Home here. Estimated cost $125,000.

Pa., Beaverdale—The School District, Summerhill Twp., c/o C. S. Kniss, Secy., will receive bids until Nov. 6 for the installation of a unit system of heating and ventilating for Wilmore school. Estimated cost $85,000. W. R. Lyon, 1204 First Natl. Bank, Johnstown, Archt.

Pa., Harrisburg—The Bell Telephone Co., L. H. Kinnard, Pres., Phila., plans to build a 6 story, 105 x 210 ft. administration, office and warehouse building on Court and Pine Sts., here. Estimated cost $1,000,000. Equipment detail not reported.

Pa, Johnstown—The School Bd., C. H. Meyer, Secy., 601 Swank Bldg., will receive bids until Nov 27 for electrical work, plumbing, heating and ventilating for a 3 story, 120 x 140 ft. school building in the 8th ward. Estimated cost $130,000. J. E. Adams, Nemo Bldg., Archt.

Pa., Lafayette—The Lafayette Sugar Refining Co. plans to rebuild refinery recently destroyed by fire, including power house and equipment. Estimated cost $300,000. Architect not announced. Owner is in the market for machinery and equipment.

Pa., Phila.—The Samaritan Hospital is having plans prepared for the construction of a 6 story hospital on Broad and Ontario Sts. Estimated cost $750,000. A. W. Barnes, 22 South 17th St., Archt.

Pa., Phila.—The United Gas Improvement Co., Broad and Arch Sts., is having plans prepared for the construction of 2 stor,y 34 x 110 ft. fuel bins, including conveyor system, also loading and unloading machinery. Estimated cost $115,000. Private plans.

Pa., Pittsburgh—The Salvation Army, 324 Diamond St., is having plans prepared for an 8 story, 80 x 120 ft. welfare and hotel building on 2nd Ave. Estimated cost $500,000. T. Pringle, Rinshaw Bldg., Engr. Equipment detail not reported. Noted Aug. 8.

Pa., Pittsburgh—The Ward Baking Co., Southern Blvd. and St. Marys St., New York, plans the construction of a large bakery on Ridge Ave. Estimated cost $1,500,000. Private plans. Equipment detail not reported.

Tenn., Knoxville—The Appalachian Marble Co., Box 837, is in the market for new electric pumping machinery for plant.

Tenn., Memphis—The Mississippi River Comn., 1st and 2nd Dists., Customhouse, will receive bids until Dec. 2, for furnishing boilers for hydraulic grader No. H. G. 2-1-1-2-23; also for furnishing turbines, pumps, feedwater heater, boiler feed pumps and electric light plant.

Tex., Celina — The city, J. E. Ousley, Mayor, plans election Nov. 28 to vote on a $50,000 bond issue for the construction of an electric light plant and water works system.

Tex., Ranger—The Oil Belt Power Co., Eastland, is having plans prepared for the construction of a power plant on Leon Lake, here. Estimated cost $1,000,000. J. E. Lewis, Eastland, Engr.

Tex., Raymondville—The city, c/o M. H. Dreyer, Mayor, plans the installation of a water and light plant and is in the market for equipment.

Wash., Deer Park — The Mt. Spokane Power Co., M. F. Mendenhall, Pres., is having plans prepared for the enlargement of present hydro-electric system, to include raising dam, new flume, wood pipe line, canals, machinery, generators, transformers, wheels, etc., also transmission lines, tanks, etc. Estimated cost $100,000. Nixon-Kimmel Co., S-169 Wall St., Spokane, Engrs.

Wash., Seattle—The Arcade Bldg. & Realty Co., Arcade Bldg., is having plans prepared for the construction of a 7 story, 108 x 120 ft. office and store building on 2nd and Union Sts. Estimated cost $500,000. H. Thomas, Arcade Bldg., Archt. Equipment detail not reported

W. Va., Berkley Springs—The Pendleton Arms Hotel Co., 67 Wall St., New York, is having plans prepared for the construction of a 4 and 5 story hotel, also casino and four cottages, here. Estimated cost $2,000,000. Hewitt & Ash, 1827 Arch St., Phila., Pa., Archt. Equipment detail not reported.

W. Va., Coalwood—The Consolidated Coal Co., Watson Bldg., Fairmount, plans the construction of a power house. Estimated cost $85,000. Owner is in the market for equipment.

Wis., La Crosse—The Hunts Hotel Co., c/o E. D. Hunt, Mgr., is having plans prepared for the installation of a new steam heating system and two smokeless portable boilers. Estimated cost $25,000. O. J. Sorenson, 216 Main St., Engr.

Wis., Milwaukee—G. Reid, 428 Grand Ave., is having preliminary plans for a 4 or 5 story apartment hotel, on Prospect Ave. Estimated cost $700,000. R. Messmer & Bro., 221 Grand Ave., Archts.

Wis., Milwaukee—E. F. Seybold, 342 6th St., is in the market for refrigeration machinery.

Wis., Racine—The Racine Pure Milk Co., 1010 13th St., is having plans prepared for a 26 x 46 ft. addition to boiler house. Estimated cost $20,000. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs. New boilers will be installed. Owner is in the market for steam driven refrigeration machinery for dairy. Contract for 125 ft. stack awarded to the Alphons Custodis Chimney Constr. Co., 140 South Dearborn St., Chicago.

Wis., Waupaca — The city, c/o F. A. Houseman, Clk., City Hall, plans to purchase emergency pumping unit, centrifugal pump motors, and machinery. Engineer not selected.

Ont., Hamilton—The Standard Underground Cable Co. of Canada, Ltd., T. D. Waring, Factory Mgr., is in the market for machinery for stranding and cabling wire and cables, also electrically driven pumps for operating hydraulic presses.

CONTRACTS AWARDED

Mich., Detroit—The Bd. Educ. 1354 Bway. Ave., awarded the contract for the construction of a 2 story, 120 x 130 ft. school building on Clinton and Chene Sts., to F. H. Goddard, 2130 Franklin St., $726,193. Steam heating equipment and plenum system of ventilation will be installed. Noted Oct. 24.

Mich., Kalamazoo—The Bryant Paper Co., Alcott St., awarded the contract for a 60 x 100 ft. power plant, and a 150 ft. stack 12 ft. at bottom, to H. L. Vanderhorst. Estimated cost $100,000.

Mo., Kansas City—The Electric Storage Battery Co., 19th and Allegheny Sts., Phila., Pa., awarded the contract for a 1 story, 160 x 220 ft. factory to the Fogel Constr. Co., 619 Reliance Bldg. Estimated cost $150,000. Electric plant comprising a 50 kw. motor generator set with auxiliary equipment for factory service, will be installed.

Mo., Odessa—The city awarded the contract for the construction of a small pumping plant and laying 35,000 ft. 8 in. sewer, cut 8 ft., to the Merkle Machinery Co., 1733 Walnut St., Kansas City, $45,000. Noted Jan. 17.

Neb., Silver Creek—The city awarded the contract for the construction of a complete sewer system, including a 10 x 13 ft. pump house and pumping equipment, consisting of 2 centrifugal pumps with 5 hp. motors or one duplex automatic electric sewage ejector, to the H. J. Petersen Co., 404 Federal Reserve Bldg., Omaha. Estimated cost $28,000.

N. Y., Syracuse—The Intercepting Sewer Bd., H. J. Hamlin, Secy., 104 City Hall, awarded the contract for machinery and equipment for sewage pumping station and grit chamber, including four 75 hp. motors and four 24 in. pumps, etc., to the Roberts Filter Mfg. Co., 6th and Columbia Sts., Darby, Pa. $76,100. Noted Sept. 12.

Ohio, Mansfield—The Dept. Pub. Welfare, Oak and Ninth Sts., Columbus, awarded the contract for the construction of a 1 story, 90 x 90 ft. power house, at the reformatory, here, to the Harbaugh Constr. Co., 26 Cherry St., Akron, $34,000.

Pa., Altoona—The School Dist., W. N. Decker, Secy., awarded the contracts for the construction of a 3 story, 224 x 232 ft. Junior high school on 6th and 7th Aves., to H. J. Conrath Co., Ariel Bldg., Erie, $551,714, heating and ventilating to the Sanitary Engr. Co., Anderson, Ind., $116,947. Noted Oct. 31.

Pa., Phila.—The Globe Ticket Co., 110 North 12th St., awarded the contract for the construction of a 9 story, 58 x 183 and 34 x 47 ft. printing plant at 112-122 North 12th St. to the G. F. Payne Co., 401 South Juniper St. Equipment detail not reported.

Pa., Pittsburgh—The Schenley Apts. Co., 3929 Forbes St., awarded the contract for the construction of a 10 story apartment hotel on Forbes, 5th and Bigelow Sts., to the Mellon Stuart Co., Oliver Bldg. Estimated cost $3,500,000. Equipment detail not reported. Noted Sept. 19.

Wash., Seattle—The Doctors & Dentists Bldg. Co., Cobb Bldg., awarded the contract for the construction of a 15 story building to be used by doctors and dentists, on 5th and Olive Sts. to the Great Northern Constr. Co., 4th and Vine Sts. Estimated cost $1,000,000. Equipment detail not reported.

Wis., Hartford—The Kissel Motor Car Co. awarded the contract for a 2,000 hp. meter type feed water heater for power house, here, to the H. S. Cochrane Corp., Phila., Pa. Noted Aug. 29.

Wis., Milwaukee—The M. Hilty Lumber Co., Ft. of 12th St., awarded the contract for two 18 x 72 power boilers to the Wickes Boiler Co., 512 North Water St., Saginaw, Mich.; 150 r.p.m. uniflow engine to the Nordberg Mfg. Co., Chicago Ave.; 312 kva. generator to the Allis-Chalmers Mfg. Co., West Allis. Specifications will be made for superheaters, feed water heater and vacuum pumps. Noted Sept. 12.

Wis., Shawano—Shawano County Bd., O. O. Wiegand, Clk., awarded the contract for a 1 story, 60 x 90 ft. central heating plant, to B. B. Shine, 224 East Walnut St., Green Bay. Estimated cost $40,000. Noted Aug. 29.

Wis., Walworth—The Walworth Condensed Mills will build, by day labor, 1 story, 14 x 60 ft. factory and 24 x 44 ft. engine room, additions to condensory. Estimated cost $20,000. Private plans. Owner is in the market for refrigeration machinery and new steam engine.